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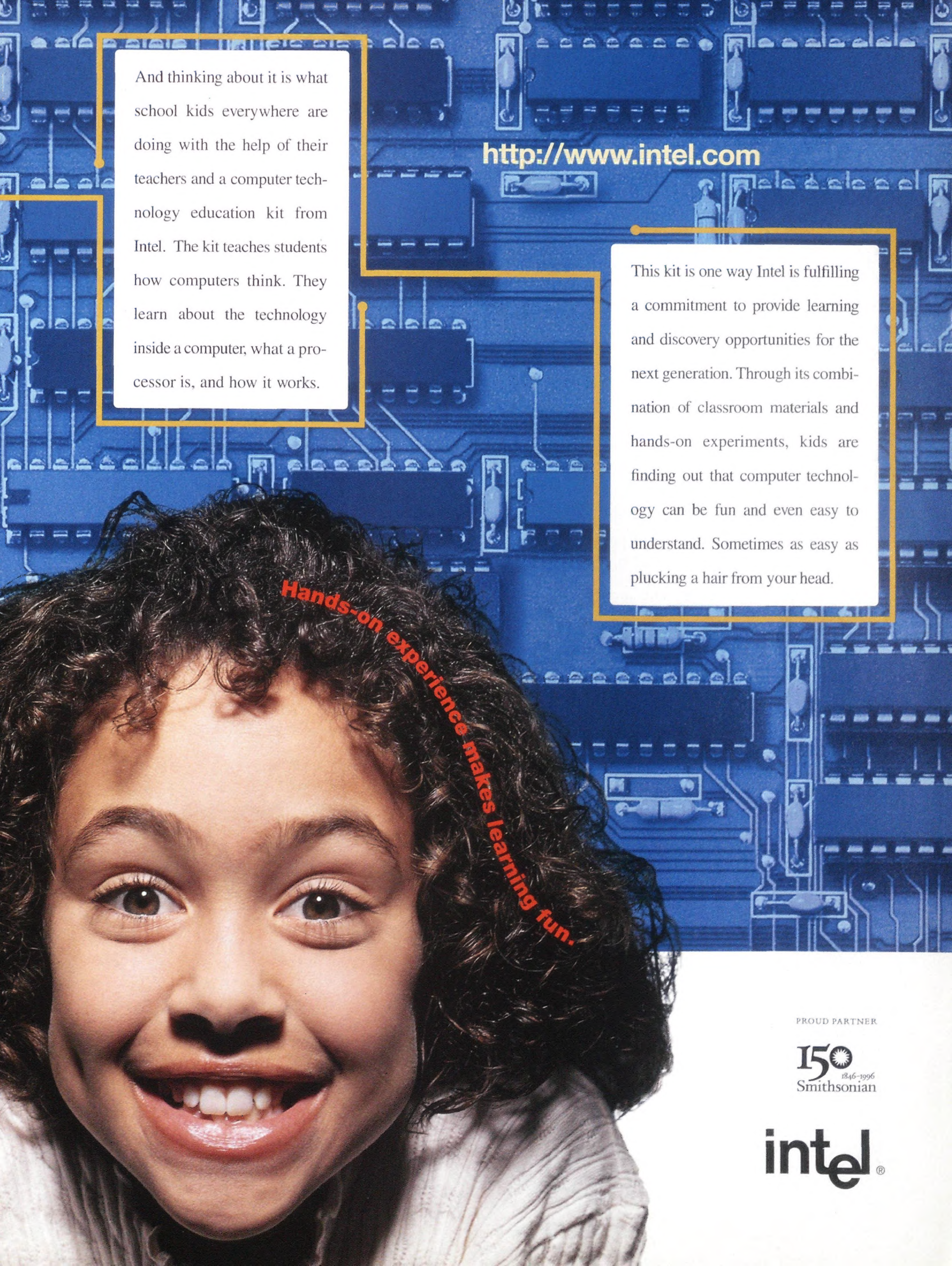
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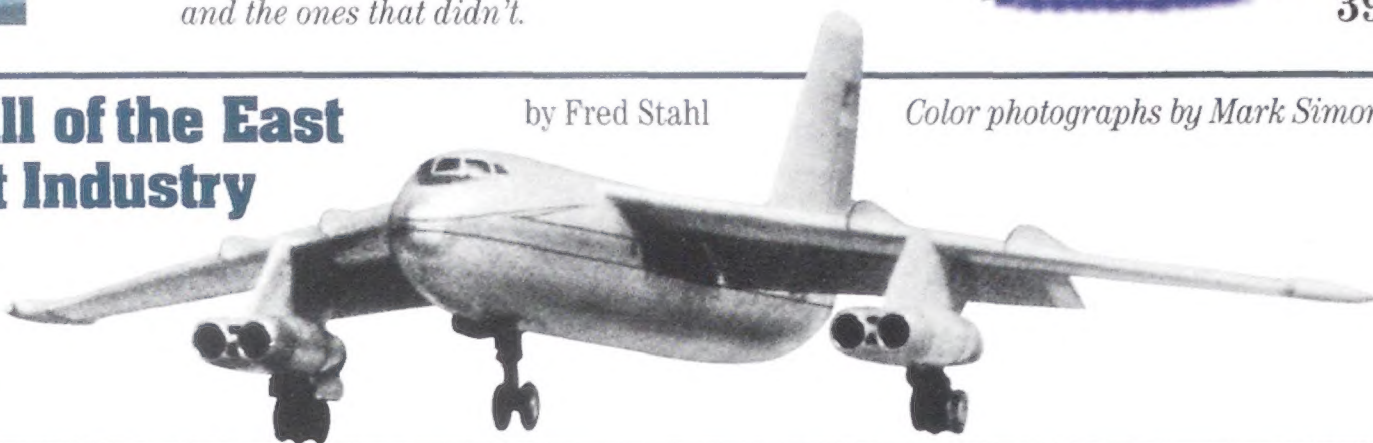
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AIR & SPACE



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Fly United

In theory, Europe is moving toward some form of unification, which, if carried to its conclusion, would result in something resembling the United States. In reality, Europe is finding the process exceedingly difficult, if not downright impossible. Will Germans ever willingly trade their beloved deutsche marks for a new unit of Eurocurrency? Will France ever accept any reform in air commerce that threatens its flag carrier, which is struggling to survive amid increasing competitive pressure? On this side of the Atlantic, we can only tremble at the economic competition we would face from a unified Europe and wonder why those countries can't see how much financial power they could wield. But Europeans aren't the only ones who have trouble getting their act together.

In theory, the various groups that make up the U.S. aviation community should be unified by the fact that they all share the same sky. Band of brothers, that sort of thing. In reality, this community is about as unified as a room full of cousins at the reading of a rich uncle's will. Despite posturing to the contrary, all these groups are competing fiercely for certain diminishing resources. The number of pilots has been shrinking, the U.S. government is trying to shift the cost of regulating and managing air commerce onto those engaging in that commerce, and airports everywhere are threatened by local governments and greedy encroachment.

The various aviation groups are responding to these problems in a puzzling way. If you take a close look, you can't help concluding that many of the most serious threats to aviation occur at the local level, yet aviation seems to know only one response: Call on the Feds for help.

Why can't members of the aviation community call on the non-aviation citizenry for support? Unfortunately, people involved in aviation have a tendency to close doors on outsiders generally, preferring to work as special interests, and pilots are often the worst

offenders ("You wouldn't understand—you haven't been in an inverted spin at 4,000 feet," etc.). A lot of aviation people run around behaving like they're in some kind of elite group, then act surprised when they get treated like one.

And they *are* treated like one: We make policy and allocate resources on the assumption that the aviation community is populated mainly by millionaires with bottomless pockets. Feeding that perception is the lingering memory of air travel as it was half a century ago: something celebrities did while dressed to the nines. And what about light airplanes? Oh, you mean those things tycoons use to shuttle between their mansions and Wall Street? Across the land, the public's attitude toward aviation couldn't be more cavalier. The public supports aviation—as long as aviation stays out of the public's back yard.

But look at reality: Military spending is shrinking, airlines are struggling, and the number of new student pilots has taken a nose dive. And nobody knows what the long-term effect of these changes will be.

As a first step toward remedying this situation, *Air & Space/Smithsonian* is supporting efforts to promote aviation as a unique part of America's heritage. Look for us at various airshows around the nation this summer, when the National Air and Space Museum will invite the public to help celebrate its 20th anniversary. As part of the celebration, a number of groups that promote learning how to fly will have an opportunity to get their message to visitors.

You can help by spreading the word. Disseminate the following facts to anyone who'll listen:

(1) Aviation, like fiber, vitamins, and a low-fat diet, is good for you.

(2) Without a vital aviation community, life in the United States will not get better; it will get worse.

(3) And as a final note to everyone who has a stake in the outcome, there is one activity in aviation that's doing very nicely, thank you. Air museums are thriving.

—George C. Larson

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Lindbergh on My Wing

Like Richard Kirkland, I was stationed on Biak Island in 1944, and I remember Charles Lindbergh's stay on our airstrip ("On Lindbergh's Wing," Above & Beyond, Oct./Nov. 1995). I give the aviation pioneer credit for making possible what was then the longest fighter mission in history (about 1,700 miles), and one I believe shortened the war and contributed greatly to our victory.

Our target was Balikpapan, Borneo, Japan's very heavily defended sole remaining source of oil. On October 14, 1944, I flew to Balikpapan on a fighter sweep originating on Morotai Island. We were to arrive at the same time as B-24s flying from northern Australia and provide cover for 40 minutes. All of our time over the target as well as all necessary combat had to be carried out on the remains of the fuel in the last of the oversized 310-gallon belly tanks.

My claim to fame was that since I was element leader for our squadron's last flight of P-38s, Lindbergh flew as my wingman. He really was "tail-end Charlie." During the fighting that day I was credited with destroying two Zeros, and I recall confirming Lindbergh's destruction of one enemy plane. Nonetheless, on a list I have of Army Air Force pilots in the Pacific Theater and the number of planes they shot down, Lindbergh's name does not appear. Of course, he being a civilian and avowed pacifist, that isn't surprising.

—Howard R. Oglesby
Rondebosch, South Africa

When Pilots Get Religion

I was dismayed by the two "religious" articles in the last issue. "Landing Rites" (Flights & Fancy) was probably meant to be funny, but treating chaplains and, by implication, religion, as a nuisance in



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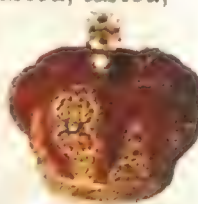
Victor Th. Engwall

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World War II didn't strike me as funny. And "Salvation Air Corps," while interesting, did not reveal the motivation behind the heroics portrayed. These folks didn't give years of their lives to satisfy a thirst for thrills. I know that giving God and love of neighbor credit for anything these days is not politically correct, but by omitting this ingredient, you made your heroes look foolish.

—Richard Titus
San Antonio, Texas

As a pastor who "slips the surly bonds of earth" as often as possible, I appreciated both "Landing Rites" and "Salvation Air Corps." I'd say that the inane Army chaplains and obscenity-muttering, whiskey-drinking P-39 drivers Edwards Park writes about have been replaced by Carl Hoffman's pilot-missionaries, who, flying the same skies 50 years later, are attuned to the needs of the real inhabitants—aid, rescue, and church planting.

Do you suppose that Divine Providence is responsible for these two stories appearing back to back? Or for keeping Park's buddies from smoking right before they were drenched with gas?

—Major Bradley Van Sant
U.S. Air Force (ret.)
Woodland Presbyterian Church
Woodland, California

The High Cost of Free Flight

In "Goodbye Yellow Brick Road" (Commentary, Oct./Nov. 1995), Federal Aviation Administration administrator David Hinson minimizes key safety issues. He claims that the FAA is "committed to implementing [free flight]

as quickly as possible" while "maintaining the safety" of the airspace system. I am an FAA air traffic controller, and I know that much of the ATC equipment in this country is outdated (vacuum tube era), unreliable, and overburdened. With the existing system and traffic flow and the increase in traffic, air traffic controllers' equipment and abilities are being pushed to their limit.

Mr. Hinson and the government should stop fantasizing about the far future and deal with the problems faced today. The fragile and obsolete ATC system is in need of an upgrade now. Pushing its limits by implementing the National Route Program and free flight without considering the capacity of the existing system is unsafe.

—Name withheld upon request

Neither Kind nor Gentle

Bruce Berkowitz's "The Kindest Cut" (Commentary, Dec. 1995/Jan. 1996) represents the type of intellectual yet uninformed thinking that abounds in Washington these days. I cringed when I read his assertion that the best solution to stagnation in aerospace research may be massive budget cuts. Congressional manipulation of research and development money for the aerospace field, and particularly for NASA, has been handicapping innovations and stifling success since the end of the Apollo program.

The real problem is that neither the president nor the Congress has a clear goal for aerospace R&D. Unfortunately, I don't think politicians will permit those of us in NASA to provide the necessary leadership, since so many smartasses like Berkowitz think that it's the NASA worker that's the problem.

—Randolph S. Reynolds
via e-mail

Carriers of Fire?

When I was stationed at Wright-Patterson Air Force Base in 1953, I was made the project engineer for ZELMAL (zero-length launch and mat landing), and I recall the first unmanned zero-length launch test conducted at Edwards Air Force Base that December ("Runways of Fire," Oct./Nov. 1995). It was late in the day, and cold. A crowd had assembled to witness the flight. The booster was ignited, and as its thrust built up, the F-84 made a perfect takeoff. The booster's glare in the evening sky made for some beautiful pictures. As its thrust diminished, the booster was ejected, and the jet engine continued to push the airplane up to about 800 feet. When the fuel was exhausted, the airplane crashed, though it hardly made a dent in the dry lake bed.

As an afterthought, I note that in Tom Clancy's book *Debt of Honor*, two aircraft carriers' air groups are grounded because the carriers have lost their propulsion systems and thus can't develop the forward speed necessary to provide the winds across the bow to launch the fighters. If Clancy's scenario is plausible, then perhaps the Navy should look into the zero-launch system as a backup to catapults.

Lt. Col. William H. Silcox
U.S. Air Force (ret.)
Incline Village, Nevada

Corrections

Dec. 1995/Jan. 1996 "5...4...3...2... ABORT": The photo in the lower left corner of p. 47 shows astronaut Michael Gernhardt, not James Newman.

"An Express of the (Near) Future" (From the Field): In the illustration, the figure for outside water pressure should read "about 9,290 lbs. per square ft. (absolute pressure)," and the intermediate and inner pressures should read "lbs. per square in.," not "lbs. per square ft."

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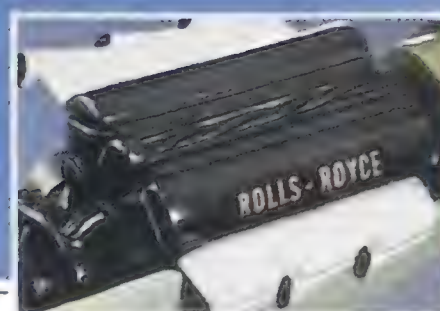
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THE 50TH ANNIVERSARY REPLICA

Gone With the Wind



NASA/LANGLEY

In the cash-strapped '90s, it's probably a sign of the times that when NASA's Langley Research Center in Hampton, Virginia, held a ceremony last October, it was to close a facility, not open one. Sort of an anti-ribbon-cutting. At the farewell for one of the world's largest and most historic wind tunnels, there were speeches followed by a wine-and-cheese reception in the tunnel's cavernous air duct. But the mood was hardly festive. "This is really a funeral," sighed one senior NASA official.

Some 200 current and retired NASA workers came to pay their respects. Many had spent their entire careers in this building, known as the 30-by-60-Foot Tunnel for the size of the opening in which test subjects were mounted. (In contrast, the Wright brothers' 1901 wind tunnel had a test section of 16 inches square, and the whole thing was about as long as a dining room table.) At Langley's sprawling campus, the 30-by-60 occupies

the equivalent of several city blocks and stands almost 100 feet high.

Closing the tunnel will save NASA an estimated \$500,000 a year, but the building will not be demolished. Like a retired battleship, it will be mothballed. Research formerly conducted at the 30-by-60 is being transferred to other facilities, along with equipment such as computers

and test stands. But the tunnel's drive system—twin 4,000-horsepower electric motors and 35.5-foot propellers—will remain, carefully preserved. No one yet knows what the future holds for the tunnel. There have been offers to take it off NASA's hands. Virginia's Old Dominion University, for one, would like to use it for aerodynamic testing of trucks and other highway vehicles.

The 30-by-60 was a subsonic tunnel, developing wind speeds of up to 110 mph. It had much to endear it to researchers, particularly its versatility. In 1931 the tunnel started operations by testing fabric-covered biplanes; by the end of its career it had tested the low-speed performance of supersonic transports and spacecraft. Concepts for much of the U.S. air arsenal and civil fleet were honed in this chamber, along with dirigibles, lifting bodies, radar antennas, paragliders, submarines, the Mercury capsule (left), and even a fanciful inflatable Goodyear airplane that tore apart on the test stand.

This was the world's first full-scale wind tunnel, meaning it could accommodate not just models but actual aircraft. Production versions of most U.S. World War II fighters were tested here for "drag cleanup." These studies resulted in the removal of performance-robbing gaps and protuberances. Such modifications increased the Bell P-39 Airacobra's top speed from 340 to 392 mph. Other tunnel achievements were in such diverse areas as general aviation stall and spin, Vietnam-

Our call for alternative uses for the mothballed tunnel evoked both legitimate and entertaining responses, all of which will be sent to Langley.

"Hang from the facility's ceiling the thousands of model airplanes constructed by aging baby boomers."

"Use it as a sound stage for Hollywood weather simulations."

"Offer 'flights' in controllable airplane models and tethered gliders."

"Make it a hurricane and tornado test

bed for housing construction studies."

"Denote it an extension of the National Air and Space Museum and use it to house large craft like the shuttle *Enterprise*, the SR-71, and the B-29 *Enola Gay*."

"Open it up for tours and lectures on the development of aircraft, space equipment, ships, and submarines that were studied there."

"Open the world's first and only horizontal bungee jump station."



LOCKHEED MARTIN PALO ALTO RESEARCH LABORATORIES

The images in this montage, captured by the Soft X-Ray Telescope aboard Japan's Yohkoh satellite, demonstrate the changes in the solar corona during the waning phase of the sun's 11-year activity cycle. The first image, on the left, was taken in November 1991, during the peak of the solar cycle, when sunspots are rampant. The final image was taken last July, shortly before the solar minimum, when coronal activity ebbs.

Built by the Lockheed Martin Palo Alto Research Laboratories in collaboration with the National Astronomical Observatory of Japan and the University of Tokyo, the Soft X-Ray Telescope was launched from Kagoshima Space Center in 1991. It provides unprecedented images of the solar corona, which normally is visible only during solar eclipses.

era fighter performance, crop duster spray patterns, and Boeing 737 wake vortex encounters.

The tunnel was also the only site for free-flight testing. Instead of being mounted on stands, remotely piloted test subjects actually flew in the airstream, with thrust from operating propellers or with compressed air, pumped through a hose, substituting for jet exhaust.

Harry Butowsky, a National Park Service historian, pointed out at the closing ceremony that the 30-by-60 has been designated a National Historic Landmark. In a booming voice that made the vast space reverberate like a revival meeting, Butowsky said that even though the tunnel is no longer operational, the park service hopes "it will be preserved and maintained as a site of memory."

Joseph Chambers, former manager of the tunnel, suggested that its legacy is in the aircraft developed there. "In years to come," he said, "when the Air Force's newest fighter, the F-22, rolls out, this place will be boarded up and the staff will be gone, but embedded in that airplane will be the work done here."

—Lester A. Reingold

Galileo Lives

The Galileo orbiter took a frying and kept on flying. Exposed to enough radiation to kill a human 50 times over, the crippled, nearly mute spacecraft skimmed past the clouds of Jupiter last December 7 while its 746-pound probe plunged into the giant planet's atmosphere. As tense as any manned launch, Galileo's arrival at Jupiter put the working lives of thousands of scientists, engineers, and support staff on the line.

They had tasted failure before. When Galileo's eight-foot high-gain antenna, necessary for normal data transmission, failed to deploy soon after the satellite was launched from the shuttle *Atlantis* in October 1989, controllers had to rely on the spacecraft's low-gain antenna. Transmitting data at a trickle of eight to 40 bits per second—thousands of times slower than a standard fax machine—Galileo now depended on its onboard computer to capture data for re-transmission. Then, last October, only weeks before arrival at Jupiter, the data recorder got stuck in rewind mode, with the spindle rubbing against the same

section of tape for 15 hours. Engineers managed to advance the tape past the weakened section, now off limits for recording or replay. They also commanded Galileo not to take pictures of the Jovian moons Io and Europa on the incoming and closest encounter in order to devote the remaining tape to data from the probe. If everything else worked, the \$1.35 billion mission would complete about 70 percent of its original objectives.

"Some people have spent 20 years on this mission," said a secretary sitting on the edge of her seat alongside other young staff members in the Jet Propulsion Laboratory's auditorium in Pasadena, California. "It's happening too fast to be nervous," said project manager Bill O'Neil.

The probe entered Jupiter's atmosphere fast enough to travel from Los Angeles to Las Vegas in nine seconds, a speed sufficient to create temperatures twice that at the sun's surface. The friction burned away a full quarter of the probe's mass and subjected its instruments to 215 Gs of deceleration. But at 3:11 p.m. Pacific time, JPL began receiving Galileo-relayed data, proving the probe had survived entry. The auditorium erupted in applause. The probe transmitted data for nearly an hour as it descended into the crushing maelstrom that would consume it.

Then the real sweating began. To achieve Jupiter orbital insertion and begin its tour of the Jovian moons, Galileo needed to fire its main engine and then shut it off on time. A dramatic readout of Doppler-shifted radio waves showed when the 88-pound-thrust Daimler-Benz rocket kicked in and when it shut down 49 minutes later. Galileo had become the first artificial satellite of the planet Jupiter. When O'Neil brought the engineering team up on stage, the packed auditorium rose to its feet in joyous applause. Some people were crying. "It feels great," said Robert Mitchell, science and sequence engineer. "It puts real meaning into the work we've been doing."

—Randall Black

From Pieces to Peacemaker

It was projected onto a big screen as befitting a Hollywood premiere, but what it really looked like was a home video of railroad cars heaped with scrap metal.

However, the more than 400 former B-36 Peacemaker crew members, maintenance men, and Convair workers who had gathered for a reunion last October at Castle Air Museum in Atwater, California, recognized that the junk on the screen had somehow been reconstructed into the RB-36H they had admired all weekend, one of only four complete airframes left.

Men ran their hands along the bomber's aluminum-and-magnesium skin or gathered in tight groups, sometimes taking a step back to reenact an aerial memory with their hands.

"We would be flying up around Alaska and we'd see MiGs, but they never would come in on us," said Ralph McLain, who as an electronic countermeasures operator accumulated almost 5,000 hours in the B-36. "Would you, with six turrets staring you in the face?" He paused and lowered his voice. "I still say this airplane kept us out of a war."

Born of fears that Europe would fall to the Axis powers during World War II, the B-36 was designed to carry out long-range heavy bombing missions from bases in the United States. The B-36 was not built during the war but entered Strategic Air Command service in 1948, when the Air Force sought to project its global power and nuclear capability in the early days of the next conflict, the cold war. "The B-36 in the 1950s was Curtis LeMay's big stick," said former B-36 flight engineer Ed Wheeler. "There was a battle over whether we were going to buy B-36s or aircraft carriers, so the word was 'fly low and noisy' to impress civilians and make it known that this was a large airplane that could do a big job."

The first models had only six piston engines. Starting with the D model, the B-36 gained four turbojet engines. The 10 engines on what was then the world's largest bomber were often described as "six turning and four burning." Because a failure of at least one engine was not uncommon in a flight of 12 hours or more, former tail gunner Don Ralston said his engines could often be described as "four turning, four burning, and two standing still." Ray Scalise, a bombsight and navigation systems technician who would later fly in Lockheed SR-71s as a test engineer, recalled a B-36 mission on

which all six reciprocating engines failed in flight, one after another. Scalise said the jet engines, which were normally operated only on takeoff and landing, became the stricken bomber's only source of power as it turned toward Salina, Kansas, for an emergency landing. After touchdown, the B-36 began to tear into the runway and careen back and forth as the crew struggled to bring it to a stop.

"We were bathed in hydraulic fluid, and because all the tires had blown, it swayed from side to side," Scalise said. "There were sparks flying and we were sure it would catch on fire." After the airplane stopped 10 or 15 feet short of the end of the runway, the pilot ordered the crew to run. "We ran through a crowd of people watching us come in. They just parted and let us through."

Similar stories were told around or inside the reunion's centerpiece, the museum's RB-36H, which came from Chanute Air Force Base in Rantoul, Illinois. After Chanute, which was recently shut down, announced it could no longer care for the airplane, Castle was placed at the top of the list of possible new homes. Wheeler and other volunteers began raising the thousands of dollars necessary to disassemble the airplane and ship it to California. "We got hold of the Santa Fe Railroad and they agreed to ship it free of charge, which really put the thing over the peak so we could get it," he said. The airplane left Illinois in August 1990 in 11 railroad cars, and by 1994 the Peacemaker was whole again. Work continues on restoring the cockpit and other interior areas.

Ralston slowly shook his head in amazement at the big bomber glinting in the California sun. "I just can't believe they got it back together," he said. Around him, an endless stream of people posed for pictures next to the aircraft or stood in line to tour its interior. In the distance, the rumble of the rail line that brought the Peacemaker to Castle could be heard across the highway.

—John Sotham

Oh, To Be in England...

It was as close as most of the spectators at the Scottsdale, Arizona airport would ever come—or want to come—to the Battle of Britain: six Supermarine Spitfires streaking across the sky with a Hawker Hurricane leading the formation, then wheeling away from the mesas in the distance. "That was bloody incredible," said John Fawcett, wiping tears from his eyes after the growl of the V-12 engines had faded. Having flown 184 Spitfire missions during World War II, Fawcett, 78, had made the trip from Seattle just for the Spitfire reunion. "You'll never see that sight again," he told bystanders. "I never thought I'd see it again."

FLIP MCCRICK



Although more than 20,000 Spitfires were built between 1936 and 1948, all but a handful have been destroyed, scrapped, or consigned to history's dustbin. At the moment, only 35 or so of these celebrated British fighters are airworthy. One of them, a Mark XVI, is owned by Arizona resident Woody Woods, and it was his son Chris who came up with the idea of bringing them together at the Scottsdale Air Fair last October.

"I went to a fly-in last November with another Spitfire," Chris says. "When we landed, everybody on the ground was just freaking out. And that was for two Spitfires! I wondered what they'd do if we had a whole group of them."

Fourteen of the Spitfire owners he contacted said they were interested in participating. Unfortunately, the airplanes are 50 years old, highly temperamental, and immensely valuable. Some owners later decided against sending their antiques to Arizona. Others couldn't get theirs restored in time. Woods' own airplane suffered a collapsed landing gear a few weeks before the reunion. Still, six Spitfires—and a Hurricane—flying in the United States was a sight no one could remember seeing since World War II.

"I got started late, and it was really



JOHN SOTHAM

something when I formed up on the rest of the planes," says Bill Greenwood, the owner of a two-place trainer version of a Mark IX that saw post-war service with the Irish Air Corps. "They looked like a school of barracuda, just kind of swaying back and forth. I wish I'd had more time to take it in, but I was too busy trying to keep in formation."

Meanwhile, on the ground, an elite group of veterans reminisced about their experiences in those intimate cockpits. "I flew most of the fighters during the war, and the Spitfire was the best of the bunch," said Reg Follett, who served as a squadron leader in the Royal Canadian Air Force. "What I remember most was its handling. It could turn inside anything the Germans had."

"It saved my life several times," Fawcett said. "I tell people that I never took off in a Spitfire—it leaped into the air. It was such a magnificent airplane, a pilot's airplane. It was so natural to fly. You didn't have to keep your head in the cockpit all the time, which meant that you were able to keep looking around the sky, and that's what kept you alive."

Whether the Spitfire was the best fighter of the war is a question better left to more dispassionate observers. But no airplane is more closely associated with the Royal Air Force victory in the Battle of Britain. And with its sleek low-wing design and distinctive elliptical wings—a legacy of the speedy Schneider Trophy racers of the 1930s—the graceful Spitfire still captivates.

"Look at that!" an ex-fighter pilot sputtered incredulously as a rare two-seat trainer taxied by. "Nobody in the back seat! Isn't that sinful?"

—Preston Lerner

Kuiper's Last Flight

Even by astronomers' monastic standards, using the flying telescope called the Kuiper Airborne Observatory was a cold, noisy, and often bumpy experience. But what was lacking in comfort was made up for in mobility. Basically a Lockheed C-141 Starlifter with a 36-inch-wide telescope in its belly, the KAO could be dispatched anywhere in the world in search of fleeting cosmic game like solar eclipses and rare planetary phenomena (see "Shadow Boxing," *Above & Beyond*, Oct./Nov. 1988).

So hearts were understandably heavy at NASA's Ames Research Center in California when the KAO returned from its final scientific sortie last September 29 and took early retirement a few days later. The reason was entirely fiscal. Astronomers want to get working on a second-generation craft called the Stratospheric Observatory for Infrared Astronomy, the marriage of a world-class telescope and a Boeing 747-SP. Cash-starved NASA managers figure that by not flying the KAO over the next five years, they'll save some \$50 million—about 20 percent of SOFIA's estimated cost.

Named for planetologist Gerard P. Kuiper, the KAO performed best when studying cosmic targets at infrared wavelengths. Cruising at 41,000 feet put the telescope and its sensors above 99 percent of the atmosphere's water vapor, which absorbs virtually all infrared energy from space. The one-of-a-kind cargo craft has flown more than 1,400 missions since 1975, and its discovery list includes the ring system around Uranus and the tenuous atmosphere that clings to Pluto.

"Right now the KAO is sitting out in the

hangar gathering dust," says Curt Laughlin, who oversaw the airplane's operation. No one is quite sure what will become of it. But flight director Carl Gillespie says the KAO "has never been flying better." If some rare astronomical opportunity arises before SOFIA is ready, Laughlin hints that the airborne observatory just might come out of retirement.

—J. Kelly Beatty

UPDATE

Departures

Moulton Taylor, the patron saint of the flying car ("Auto Pilots," Dec. 1995/Jan. 1996), died last November at age 83, one week after being inducted into the Experimental Aircraft Association Hall of Fame.

Douglas "Wrong Way" Corrigan, who flew the Atlantic in 1938 despite the Department of Commerce's refusal to permit him to make the flight, died last December in Orange, California ("Wrong Way Corrigan Revisited," June/July 1988). He was 88.

John Mitchell, commander of the fighter squadron that downed Admiral Isoroku Yamamoto in Papua New Guinea in 1943 ("Who Shot Down Admiral Yamamoto?" Feb./Mar. 1992), died last November in San Anselmo, California, at age 81.



Last September an Air & Space team at the Reno Air Races explored Apple's new QuickTime VR photographic system. QTVR photos are not captured on film, but rather are digitized and uploaded into a personal computer. The panoramic images present a window on the screen that allows the viewer to pan 360 degrees and zoom in and out. The Reno results can be downloaded to Windows and Macintosh OS computers from our Website at http://www.airspacemag.com/Reno/Reno_Home.html#VReno.

The composite image above includes representatives from all four classes of air racing and then some. Left to right: Biplane class, Patti Johnson and Mong Sport; The Golden Age, Delmar Benjamin, Gee Bee R-2 replica; Unlimited Class, John Penny and Lyle Shelton, Rare Bear; AT-6/SNJ class, Fred Johnson, Miss Appropriation of Funds; Formula One class, Jon Sharp, Nemesis.

The Rodney Dangerfield of Spacecraft

Jim Willit looked disappointed. He was sitting next to me at a Jet Propulsion Laboratory press conference on the latest findings of Ulysses, the first spacecraft to fly over the poles of the sun. NASA program manager for Ulysses, Willit had witnessed the kind of crushing press turnout that Voyager and other spacecraft can generate. But today there was no traffic jam, no crush of eager reporters. It was easy to get a parking space in the main lot, where the speed limit sign speaks metric—"24 km/hr"—and adds sheepishly "(15 mph)."

The press conference followed a three-day scientific meeting last October on Ulysses' voyage and marked the unofficial end of its primary mission. But unless a hidden throng of journalists watched the televised briefing at remote locations, Ulysses was getting the press equivalent of the cold shoulder.

Goddard scientist Steve Maran introduced five Ulysses scientists, who began talking about fields and particles, particles and fields. Ulysses' instruments were designed to study the magnetic fields of the sun and the ionized particles trapped in those fields. Although the abundances, charges, and velocities of those particles and the strengths and orientation of solar magnetic fields paint a large-scale portrait of our star, Ulysses' suite of sensors did not include a camera. No pretty pictures.

The briefing ended with the traditional call for questions. But unlike previous encounters, when journalists frantically waved their hands, there wasn't a single question from the press. "I guess we did a pretty good job of explaining," shrugged the upbeat Maran.

Willit thinks that if the Ulysses project wants to capture public interest, it needs to generate a flashy computer graphic showing the heliosphere, the swarm of ionized particles and tangled magnetic field lines that the solar wind blows around the sun like a huge soap bubble.

"Ninety percent of spacecraft data are non-imaging," Willit says. To be fair, Ulysses previously got good press coverage by a number of the science stalwarts. But the lack of photos has the public asking, "Ulysses who?"

The fact is, Ulysses, launched in 1990, has had a wildly successful mission, exploring uncharted territory and pushing the envelope for spacecraft performance. Using Jupiter's gravity to fling it out of the ecliptic, the flat-as-a-plate racetrack in which the planets (except Pluto) hurtle

around our star, the 650-pound European Space Agency craft became the fastest human-made object, zipping by Jove at 61,380 mph. Ulysses discovered that, unlike Earth and other magnetic bodies, the sun's magnetic field isn't stronger at the poles, contrary to theory. Another finding: Because the solar wind blows roughly twice as fast as it leaves the poles, the heliosphere is shaped roughly like a peanut, with a narrower (and slower) zone near the solar equator. Ulysses also detected low-frequency seismic "ringing" of the sun, using magnetic field lines as transmitters. There's more, but it's all fields and particles.

European Space Agency project scientist Richard Marsden reported that Ulysses was in good shape to complete a long polar orbit out to the distance of Jupiter, returning to the sun's poles in 2001. Maybe they'll have a better turnout for that press conference.

—Randall Black

Assume the Cheese Head Position

Diehard Green Bay Packers fan Frank Emmert flew a Cessna from Superior, Wisconsin, to Cleveland the Sunday before last Thanksgiving to cheer his team to victory, and on arrival donned his cheese head—an outsize wedge of

cheddar-yellow foam that's de rigueur for Packers backers. After the holiday weekend he was homeward bound in the 172 with flight instructor Baron Bryan at the controls. Emmert had a Packers game on a navigation radio and his cheese head in his lap.

En route, the Cessna began collecting ice on its wings, and Bryan decided to land at Stevens Point, Wisconsin. The airplane broke out of the clouds a few hundred feet above the airport, and Byron began a turn at the airport perimeter. Just then, Emmert said, the engine quit, "just like you shut off a switch: nothing."

Realizing that a crash was imminent, Emmert buried his head in his trusty cheese head and wrapped his arms around it. Moments later the Cessna tore through a stand of trees, shedding its tail and a wing in the process. Bryan was knocked unconscious when his head slammed into the yoke and instrument panel. Emmert broke an ankle and received cuts on his arms, but thanks to his cheesy pillow, his face, neck, and chest were largely unscathed. He vows that "whenever I fly, that cheese head will be there," adding that the investigator from the National Transportation Safety Board seemed so impressed by the efficacy of his impromptu safety device that Emmert gave him his spare.

—William Garvey

ERIK HILDEBRANDT



Last August, to commemorate the 50th anniversary of VJ Day, California's Yankee Air Museum teamed up with the U.S. Navy to launch World War II aircraft off the carrier Carl Vinson as it steamed into Pearl Harbor. The aircraft qualified for non-catapult carrier duty by getting airborne in under 1,000 feet on a simulated flight deck in Alameda, California. Then, a dozen aircraft—two F4U Corsairs, three B-25s, an SNJ trainer, a Grumman Wildcat, two TBMs, and three Grumman amphibians—were craned onto the real flight deck for the 10-day cruise to Hawaii. Upon arrival, the Wildcat was the first to be launched. Interspersed with the rest of the antiques were two F/A-18s, ordered to launch as tactical cover for the Vinson.

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The Life of Louise Thaden

At 5:00 on a summer afternoon, Louise Thaden, 30, and her friend Blanche Noyes, 36, neared the end of a journey they'd begun 15 hours earlier. It was September 4, 1936, and Thaden was a contestant in the Bendix race, a prestigious cross-country dash from New York to Los Angeles. Flying a Beech Staggerwing biplane far less powerful than the other aircraft in the race, Thaden thought it highly unlikely she would finish in the money. Still, she intended to do her best.

Thaden and Noyes left Floyd Bennett Field just before dawn and flew halfway across the country before stopping to refuel in Wichita, Kansas. Aside from a thunderstorm outside of St. Louis, they had met few obstacles. But after leaving Wichita, they encountered a strong headwind, which buffeted them about and reduced the biplane's ground speed to a dispiriting 153 mph.

Louise Thaden was glad to be on the ground after an endurance flight of over 22 hours in 1929 (below). Right: Vincent Bendix congratulated Thaden for winning the 1936 Bendix trophy in a race she flew with pilot Blanche Noyes (at right).

After crossing the last mountain range several hours later, Thaden began her descent toward Los Angeles. Blinded by the setting sun, she had trouble finding the airport, and when she finally located it, she overshot the finish line. Pulling the Staggerwing around in a 180-degree turn at high speed, Thaden and Noyes pulled a few Gs as they dodged Marine Corps aircraft and zoomed over the finish line—crossing it in the wrong direction. "Nothing like coming in through the back door!" yelled Noyes.

At 5:09 p.m. Thaden's race was over.

Figuring that the Bendix trophy had been won hours earlier, Thaden brought her blue and white biplane down and tried to taxi unobtrusively to a spot far from the spectator-filled grandstands. Immediately a group of men started running alongside the Staggerwing. Fearing that she had angered airport officials or that her airplane was falling apart, Thaden asked Noyes to open her window and find out what the men wanted. "Get out of there," barked one of them. "We think you've won the Bendix!"

And so they had. They were the first

women to do so, and Thaden received a prize of \$9,500 for piloting the winning aircraft.

There was no question that she loved to fly. Thaden's enchantment with aviation moved her to make speeches and write articles promoting it. A natural storyteller, Thaden had her work published in newspapers and magazines. She also wrote a book, *High, Wide and Frightened*, published in 1938. Last year

the National Air and Space Museum made a collection of Thaden's writings, letters, telegrams, and photographs available to researchers.

An examination of the photographs reveals that, like many of her contemporaries (most notably Amelia Earhart), Thaden had the right look to win America's affection. She was tall and athletic, but still feminine and pretty. Thaden's writings reveal a sensitive, intelligent woman who longed for the tranquility of flight. But the overall impression is that Louise Thaden was an awfully good sport.

She had to be, for she was flying in a time when flight was new and largely unregulated. Pilots were getting a lot of coverage from newspaper reporters, who described their adventures as thrilling and glamorous. Thrilling, yes; glamorous—usually not. In her attempts to set en-



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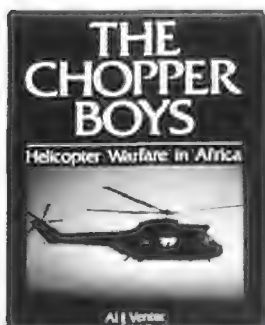


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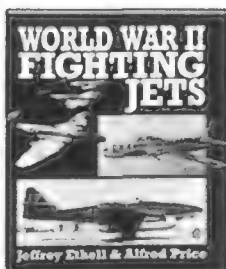
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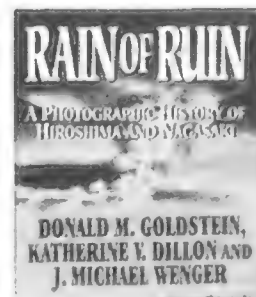


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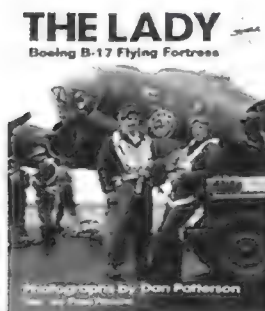
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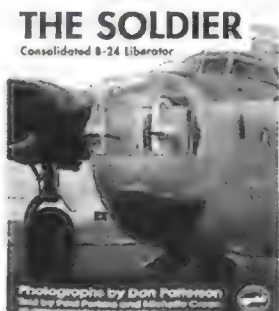
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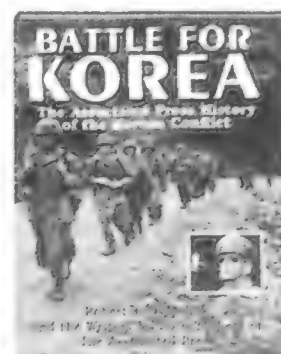


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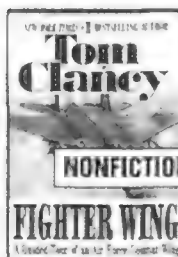
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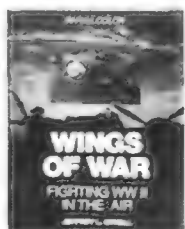
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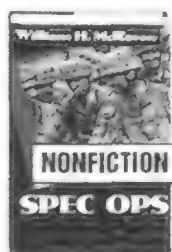
1917 \$16.95x



0992 \$24.95



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0430 \$27.95



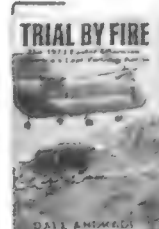
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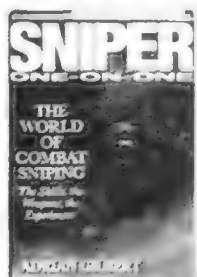
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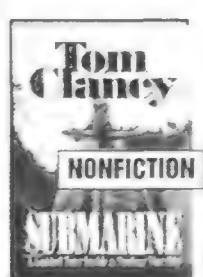
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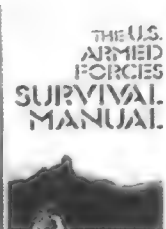
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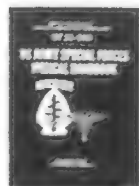
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duration, speed, and altitude records. Thaden braved freezing cold and blazing heat, oxygen deprivation, exhaustion, temporary hearing loss, and, always, the possibility of losing her life.

When Thaden was flight testing an airplane that she used to set an altitude record in 1928, she experienced three consecutive engine failures—all because mechanics had failed to detect a blocked vent on the gas tank. "That night I went out and stayed up too late, trying to forget," Thaden wrote in her book. "Three forced landings in a row were too much." And in 1929, while she was setting a solo endurance record of 22 hours over Oakland, California, in an open-cockpit airplane, the spinner on the propeller flew off and nearly hit her in the head.

One wonders why she didn't just walk away from such a risky sport, but the appeal of flying was too strong for Thaden to resist. Of the 22-hour endurance flight she wrote: "The steady roar of the engine, the feel of the rudder pedals beneath my feet, the smooth response of the plane to each slight command, sent a warming glow through my body, and prickly sensations ran up and down my spine."

In the summer of 1929, Thaden entered the nation's first cross-country race for women, which columnist Will Rogers dubbed the Powder Puff Derby. While ferrying her airplane, a Travel Air, from the factory in Wichita, Kansas, to her home in California, Thaden was poisoned by carbon monoxide, which seeped into the cockpit due to a faulty engine cowling. Though quite ill, she managed to land her aircraft without incident and recover in time for the race.

Setting out from Santa Monica, the entrants flew to San Bernardino, the first leg of the race. After eight days, Thaden won, reaching Cleveland ahead of her competitors, including Amelia Earhart, who came in third. The grueling conditions prevented many of the women from even finishing the race, and one woman was killed. With an eye toward publicity, race officials had scheduled too many stops in small towns that weren't prepared to receive the fliers. After landing, the women had to sign autographs, guard their airplanes from curious locals, and attend nightly banquets. All of this left too little time to get enough sleep and attend to their aircraft. None of which deterred Thaden. "The public was skeptical of airplanes and air travel," she wrote. "We women of the Derby were out to prove that flying was safe; to sell aviation to the layman."

There was no shortage of women eager to take on the job of "selling aviation," but few had the money to do it. Flying was an

expensive sport, and the corporate backing often necessary to participate was always in short supply, especially during the Depression. It certainly helped to set a few records or win a race and get one's name in the paper. The rivalries that sprang up were generally cordial, but there were occasional rumors of contestants' airplanes being sabotaged. True to her nature, Thaden remained friendly with her competitors—with one exception. She had a falling-out with Blanche Noyes, her Bendix partner.

Thaden had asked Noyes to accompany her because she felt sorry for her recently widowed friend. But in the years following the race, Thaden believed that Noyes—in a series of speeches and press releases—had begun misrepresenting her own role in an attempt to claim credit for the win. In a 1949 letter to Noyes, Thaden wrote: "Your snowball from such constant rolling has built itself into rather large proportion, so large, now that the sun has broken out from behind the clouds, it might topple over and bury you, unless you are careful to stand at a safe distance." (Unfortunately for historians, the Thaden collection contains no record of a reply from Noyes.)

By this time, Thaden's record-setting

days were long over. She had married in 1928, and 10 years later she ended her flying career to raise two children. As World War II began, Thaden received an offer to ferry military aircraft, which she longed to accept. But she opted to stay with her family, moving with them from Pittsburgh to rural Roanoke, Virginia. Because of the war, no civilian flying was allowed. This was a difficult time for Thaden, who struggled with and finally triumphed over alcoholism. After the war ended, Thaden once again took joyously to the air, this time as a lieutenant colonel in the Civil Air Patrol.

Despite Thaden's winning personality and her hard work, her flying never brought her fortune, nor did it bring the kind of fame that her good friend Amelia Earhart achieved. But neither fame nor fortune had ever been her goals. Louise Thaden wanted simply to fly.

—Diane Tedeschi

Museum Calendar

Except where noted, no tickets or reservations are required. To find out more, call Smithsonian Information at (202) 357-2700, Mon.–Sat., 9 a.m.–4 p.m.; TTY: (202) 357-1729.

February 7 "The Search for the Edge of the Universe." John Huchra of the Harvard-Smithsonian Center for Astrophysics discusses the distribution of galaxies in the cosmos. Langley Theater, 7:30 p.m.

February 8 Black History Month Lecture. Chauncey E. Spencer speaks about his experiences as a Tuskegee airman. Langley Theater, 7:30 p.m.

February 15 "22 Years of Flying Over Washington." Traffic reporter Walt Starling tells stories about his 20,000 hours in the air. Langley Theater, 7:30 p.m.

February 24 "The New Solar System." See the planetarium's new show. Einstein Planetarium, 10:00 a.m. to 4:00 p.m.

March 6 "Cosmic Candles: Measuring the Distances to the Galaxies." Wendy Freedman, an astronomer with the Carnegie Institute, talks about her work with the Hubble Space Telescope. Einstein Planetarium, 7:30 p.m.

March 14 "The Women of Project Mercury." Listen to former astronaut trainees, including Jerry Cobb and Wally Funk, discuss their stories about the Mercury program. Langley Theater, 8:00 p.m.

March 21 "My Detroit Miss: Exploits of a P-51 Fighter Ace." Urban L. Drew speaks about his experiences battling the Germans during World War II. Langley Theater, 7:30 p.m.

ARTIFACTS



In 1985 Cindy Berkley became the first woman to fly as a first officer for United Airlines. Four years later she again made history, becoming United's first captain. When Berkley became pregnant, United designed this uniform of blouse, smock, and trousers to accommodate her through her sixth month of pregnancy. Last year United donated the uniform to the Museum.

THE DC-3 IN COMBAT

Since its first flight in December, 1935, the Douglas DC-3 was an instantly popular airplane that was originally designed for passenger service. When World War II broke out, the military found that its versatility could be utilized for combat missions. With modification, the DC-3 became the C-47 and it served with distinction in all theatres for the Allies. Decades later, at the dawn of the era of combat jets, the C-47s were an integral part of the Vietnam War.

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It is a historic series that pays homage to the aircraft that defended democracy. Toy Showcase, of Monsey, New York, is offering this series until January, 31, 1996, so act fast. The price structure is: 1 unit \$64.99, 2 units \$59.99 each, 3 units \$57.50 each, 4-7 units \$55.00 each. All orders are ppd in the U.S. Send check or money order to: Toy Showcase, 279 Viola Rd., Monsey, NY 10952. Visa MasterCard accepted (203) 755-7714.

RAF Transport Command
Operation Market Garden
Arnhem September 1944

USAAF
Operation Overlord
Normandy June 6, 1944

US Navy Chuting Stars
Nas Los Alamitos, CA 1963

USAF Airways and Communications Service
1959

FC-47 "Puff" Gunship
4th Air Commando Squadron Da Nang

AC-47D "Spooky" Gunship
432nd Tactical Fighter Wing
Udon RTAB 1970

Air Rescue Service, USAF
Detachment Six, Hamilton Field
San Francisco, CA
1948



At Wicks' End

When the 1993 tragedy in Waco put the Texas town on the map and in the minds of millions, it brought the place into sharp focus for me. Waco has had a special place on my own mind's map for half a century.

Some 50 summers ago I was flying bombers out of Laughlin Field in Del Rio, Texas. Laughlin was a training field for pilots of the Martin B-26 Marauder. In all the years since Del Rio, whenever I've thought of the B-26 I've thought of Gordon Wicks, and whenever I've thought of Gordon Wicks, I've thought of gorilla movies in Waco.

Sometime in 1942 a senator named Harry Truman looked at some figures and asked: "How come more men are being killed in training in the B-26 than in combat?" B-26 crews at the time thought it a very bright question to come out of a politician.

So the old short-winged B-26s—later known as "straights"—were grounded, and new models, with slightly longer wings, took their place. Longer wings didn't make the B-26 noticeably safer, only a little more sluggish and heavier on the controls.

During transition training at Laughlin I learned that B-26 pilots drank more than any category of people I had ever known. Most didn't drink on the nights before they had to fly, but they made up for it on all other nights. The heaviest drinkers were the instructor pilots, all of whom had requests in for combat duty overseas, where flying was safer—the B-26s there were newer, in better shape, and flew far fewer hours. In Del Rio, pilots didn't drink for social reasons, nor did they drink to sing "Way Down Yonder in the Cornfield." They drank to achieve a small stretch of oblivion.

Sometimes they did sing, and sometimes it was a song about the B-26:

*The Marauder's a very fine aircraft
Constructed of rivets and tin,
Top speed well over three hundred
Especially when you're in a spin.
Oh, why did I join the Air Corps?*

*Mother, dear mother
knew best.*

*Here I lie 'neath the
wreckage,*

*Marauder all over
my chest.*

They also liked to sing about a hard-luck instructor pilot named Gordon Wicks. If a B-26 was in trouble and coming in for a gear-up landing, everyone would say, "Damn, it's Wicks," and too often they'd be right. If a buzzard went through a windshield and the pilot had to bring the airplane down on ranchland, then walk six miles to a phone because he didn't have a dime on him and the farmer wouldn't let him use the family phone, the pilot was surely Wicks. There was a song they sang about him:

*Keep those
marshmallows on
hand,*

*Oh, keep those
marshmallows on
hand,*

*Keep those
marshmallows on
hand,*

*Ol' Wicks is comin'
in to land,*

*I'm gonna kill
myself, O precious me.*

One rainy night, when he wasn't scheduled to fly the next day, Wicks was weaving his way back to his quarters from the officers' club. He was very tired. When he spotted a concrete mixer left from some construction going on at the club, he decided to curl up and rest for a while, out of the rain. He woke the next morning when the sun got to him through

the open mouth of the mixer, and the rest of the day he walked around bent over like the letter C.

One hot Sunday afternoon in July, I was lying around the bachelor officers' quarters when a sergeant from Operations found me. "They want you to fly a B-26 over to Waco," he said. "Avery's stuck over there and he needs something.



PAUL SALMON (2)

Wicks will fly over with you."

Major Avery was commanding officer of my training squadron. "Aw, no," I said. "What does Avery need?"

"Beats me," the sergeant said. "But he asked for you. Said you needed the flying time."

"And Wicks?"

"We just got lucky, finding Wicks."

"You got lucky," I said.

He drove me to Operations, where Wicks was pacing and cursing. He was wearing clean pressed cotton gabardines and was already late for his date with the Del Rio girl he was engaged to. (People got engaged a lot in the early 1940s, particularly B-26 pilots.)

We carried seat-pack parachutes out to the flightline and found the airplane with the right numbers on the fuselage. "I'll fly," Wicks said as we climbed in. "You ride copilot." I couldn't argue with him. He was still a second lieutenant, like me, but he'd been commissioned longer. And he was an instructor pilot.

Wicks spread a handkerchief across his lap to keep his pants clean for his date, then buckled his seat belt and started the engines. He was still cursing. Once we were clear of the field, he lowered the nose, pushed up the propeller settings and throttles, and flew to Waco at an altitude of 50 feet, scaring cows, and an airspeed of 220 mph, fast for a B-26, even a stripped-down one without bombs or gun turrets.

Major Avery was waiting for us in front of Operations at the field in Waco. "What took you guys so long?" he asked. Wicks didn't answer him. Neither did I—Wicks had all the rank.

What the major needed was a propeller control from the B-26 we'd just flown. He wanted to get back to Del Rio, where his wife was. Wicks and I would spend the night at the field in Waco and get a new part the next day.

We decided to get a ride into town. While we were standing on the sidewalk, wondering what you do on a Sunday afternoon in Waco, a Chrysler convertible with three girls in it drove by and slowed. Two of the girls waved. "Come on, Wicks," I said, but Wicks didn't move. The Chrysler had pulled to the curb. "We have \$3.20 between us," he said. We had taken inventory on the ride into town.

"Those girls are up to their bellybuttons in money," I said, "and who cares? They need us."

"I'm engaged," Wicks said. The Chrysler started up and drove off. The blondest blonde looked back at us and shook her head.

"You dumb son of a bitch, Wicks," I said. "You make your own bad luck." We went to a movie house offering a triple feature—three gorilla movies. Wicks liked gorilla movies.

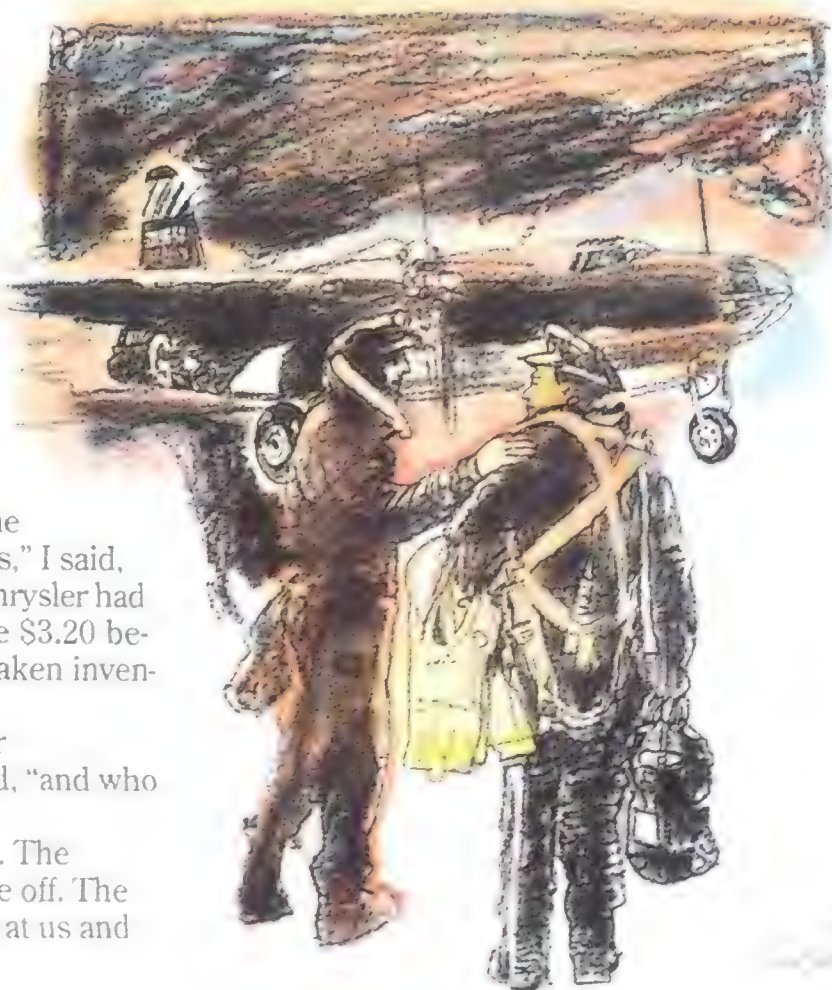
Two months later I was at Barksdale Field in Shreveport, Louisiana, in a replacement training unit where I was assigned my crew: a copilot who'd never been in a B-26 before, a bombardier-navigator, and three gunners. They were all younger than I was. I was 21. I had trouble sleeping.

In the B-26, if an engine quit right after takeoff, the airplane tended to go over on its back. We lost a number of crews in the seven or eight weeks I was at Barksdale. For a stretch a chaplain showed up to say a prayer during the morning briefing. My copilot, a big guy named Bob Gridley who had played some football, followed me out of one briefing right after the chaplain's prayer. "Reminds me of the huddle before a high school football game," he said. "Except here nobody cries."

Just before I left Shreveport with my crew for a combat tour in Europe, where life was safer, I got the last word on Wicks. He had had an engine quit right after takeoff from Laughlin Field and evidently had done the right thing—cut both engines and landed straight ahead. He'd have survived it too, except he scored a direct hit on an Esso truck on the highway outside Del Rio.

Now every time I think of the B-26 I think of Wicks, and every time I think of Wicks I think of those damned gorilla movies in Waco.

—Arnold Benson



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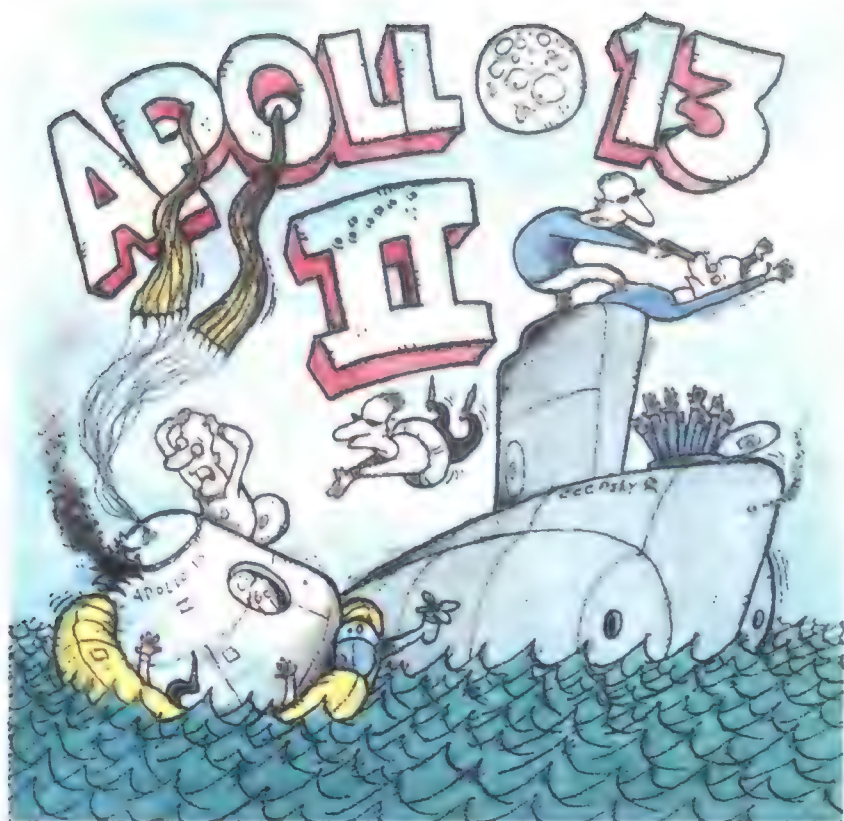
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—New York Times Book Review



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DAVID CLARK

Flush with the success of its blockbuster Apollo 13, Universal Studios has announced plans for Apollo 13 II, a sequel scheduled for release next summer. Story and script will be by screenwriter Joe Eszterhas (Basic Instinct, Showgirls, Jade). Replacing director Ron Howard will be writer-director James Cameron (The Terminator, Terminator 2).

"We're taking this to the next level," says production executive Marty Marty. "The can-do, A-OK astronaut thing worked great, but there is such a thing as too much clean-cut." Following is the preliminary treatment for the script.

It's summer, 1970, and astronauts Jim Lovell (Tom Hanks), John Swigert (Kevin Bacon), and Fred Haise (Bill Paxton) learn that they're "going to try it again." The trio, whose ill-fated Apollo 13 voyage left them miles from the moon but a hair's breadth from death, reunite and lift off for a long-awaited rendezvous with Luna. Watching the launch from the VIP bleachers at Cape Kennedy is Swigert's new girlfriend, Tammy (Sharon Stone). What is her terrible secret? She won't tell, and, indeed, we never find out.

Meanwhile, in Houston, morale is mixed. On one hand, the mission is a go; on the other hand, a series of brutal murders is terrorizing the facility. One by

one, the tech specialists who brought Apollo 13 home safely are waking up dead, stabbed with their own slide rules. In their ruthlessness to win the cold war, the Soviets have hired a pair of professional sociopaths, the evil Nigel (Jeremy Irons) and his eviler twin Derek (Alan Rickman), to subvert the U.S. space effort.

As their fragile spacecraft hurtles toward the moon, Lovell broods. He had promised his plucky, feisty wife Marilyn (Kathleen Quinlan) he'd retire. Now he's haunted by her words: "If you go to that moon and something terrible happens, I won't be here when you don't get back." Haise's weepy, trying-to-be-brave wife weeps, and tries to be brave. Suddenly, at T plus 14 hours, two telemetry specialists and a fuel engineer are found dead in a men's room, smothered with their own pocket protectors. Enter homicide detective Doug Michaels (Michael Douglas), who ends up questioning astro-girlfriend Tammy. Talk about liftoff! Douglas and Stone do their trademark hunter-prey, spider-fly *pas de deux*, culminating in a graphic and kinky freefall love-making sequence in the KC-135 zero-G simulator.

When Michaels gets back to Earth, he learns that the Apollo ground team in Houston has been decimated. Nigel and Derek have killed or kidnapped everyone except stoic, tight-lipped flight commander Gene Kranz (Ed Harris).

Michaels realizes he's been used: Tammy has been in on this from the start. After a high-speed car chase around south Florida or Houston or wherever, he captures Tammy and wrings a confession from her. She reveals that Nigel and Derek will be escaping in a Soviet sub lurking in the waters off Galveston. Michaels enlists the assistance of Navy

security specialist Bob Smith (Arnold Schwarzenegger), who joins Michaels in pursuit of the killers.

Now the pace picks up. In Houston, Kranz has to make the toughest call of his career. But he has no choice: He contacts the Apollo 13 II crew and tells them that since there is not a soul left except himself to monitor the flight, the mission is scrapped. They must abort at once.

Lovell, Swigert, and Haise absorb this blow. It hurts. It hurts bad. After a series of deeply moving toasts with dehydrated cooking sherry, they fire the thrusters and head back.

Meanwhile, Michaels and Smith reach Galveston. The Navy has pinpointed the sub on which Derek and Nigel are escaping, but Pentagon red tape makes it impossible to launch a chase in time. As the evil twins trade smug quips and drink champagne, Michaels and Smith steal a pair of Jet Skis and zoom off across the Gulf in hot pursuit.

After a breathless chase covering a thousand nautical miles, Michaels and Smith close in on the escaping sub and disable it with their .38s. It surfaces and its crew surrenders, but Nigel and Derek commandeer a motorized life raft and make a run for it, just as the cops' Jet Skis run out of gas. The snickering evil twins head toward certain escape...

...just as the Apollo capsule descends, lands smack on the life raft, and sends the vile twins to a well-deserved death. But it's not over yet: The collision has caused an explosion on Apollo 13 II! Lovell, Swigert, and Haise flail helplessly in the water. While Michaels holds the sub crew at gunpoint, Schwarzenegger's Smith leaps into the surging Gulf waters, swims to the exhausted trio, and singlehandedly hauls them out of the water and onto the sub.

Back home, Haise's weeping wife falls, weeping, into his arms. Swigert tells the handcuffed Tammy to go to hell. Michaels and Smith trade quips of mutual admiration. Lovell, with a wistful gaze at the moon, vows quietly, so his wife won't hear, that someday, he will return.

—Ellis Weiner

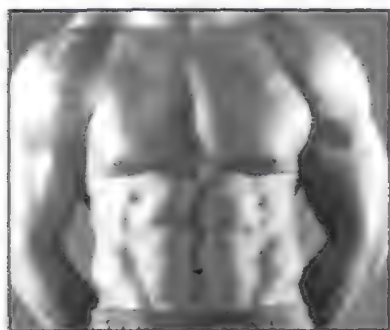
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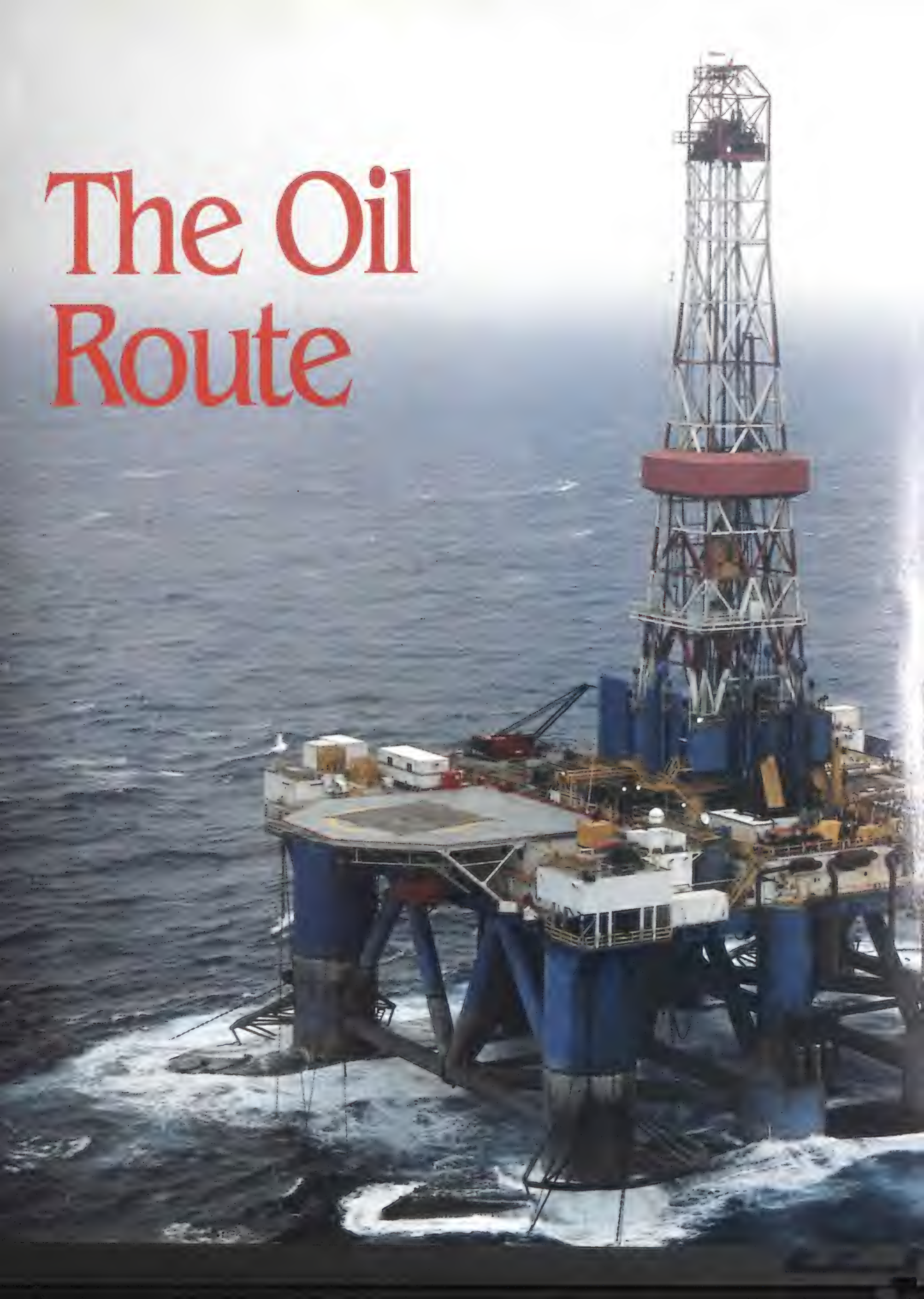


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The Oil Route





It's a small world for an American company that flies a French helicopter to service an Australian oil rig in the South China Sea. For the pilots who have to land on the rig's pitching deck, the world becomes even smaller.

by Tom Harpole

Photographs by Geoffrey Clifford



The job of American pilot Mike Chase and Chinese pilot and interpreter Huang Wei Jun becomes really tricky when gusts blow through the oil rig's structures, forcing them to make constant adjustments to the helicopter's power and flight controls.



At 6:30 a.m. on the dreariest of mornings, a couple of helicopter pilots and three mechanics unchain their black Wu Feng one-speeds from the fence alongside the Shenzhen Airport Hotel in southern China. By now used to the frequent coastal drizzle, they pedal the mile to work, weaving through a cacophonous mass of hundreds of Chinese bicyclists, who assertively thumb their tinny handlebar bells as they skirt pedestrians carrying shoulder-pole loads. Today the crew's ride is punctuated by a dozen blasts thundering down from the foothills just inland, which are being dynamited for landfill.

A few minutes later, the crew, all expatriates from Anchorage, Alaska, park their bikes at the China Southern Airlines Hotel, where their American employer, ERA Aviation, has an office. ERA is based in Anchorage but has a mission in China: to ferry crews and groceries to an offshore oil drilling platform in the South China Sea. ERA got its outpost in China through a partnership with the Zhuhai Helicopter

Company, a subsidiary of China Southern Airlines. Under an agreement between the two companies, ERA supplies one helicopter and training for the Chinese mechanics; Zhuhai provides a helicopter plus pilots and navigators who can communicate with Chinese air traffic control. In addition to transporting crew and supplies, ERA's helicopter also flies medical and weather emergency evacuations for the oil rig's 86 workers.

The morning check-in of the oil rig roughnecks, whom the pilots playfully call "bubbas," is at once systematic and desultory. A guard searches their luggage, looking for illegal drugs or alcohol. The full complement of 15 bubbas and their bags is weighed. A video explaining the safe boarding and ditching of a helicopter at sea plays twice, once in English and then in Chinese. The offshore oil rig they will fly to is a kind of tower of Babel, employing people speaking 14 different languages. "We all get along pretty well," one passenger tells me; "no one can tell what

An assist from an auxiliary power unit (foreground) provides the kick needed to start the Puma's turboshaft engines.

anyone else is saying."

For the helo pilots who work the hundred or so other offshore rigs around the world, this off-to-work-we-go scene would look familiar: a languid group of unshaven men yawning on the tarmac of a coastal heliport in the wind and drizzle. Two helicopters, a Bell 214ST and an Aérospatiale Super Puma AS 332L with its side door slid open, wait in silence among the commercial flights that will launch passengers to points on the mainland. With its porpoise nose, the Bell, owned by Zhuhai, looks like a cetacean; the Super Puma, tall and blocky, could have been designed by Peterbilt.

The \$12 million Super Puma can lift 19 passengers and two tons of fuel, which it burns at a rate of 1,200 pounds per hour. "I saw one for the first time in 1973 in Nigeria," recalls ERA Avia-

tion captain Mike Chase, who flew helicopters in Vietnam. The 9,832-pound Super Puma, which has a range of over 500 miles, is perfectly comfortable cruising at 155 mph and climbing at a rate of nearly 1,600 feet per minute.

Chase and Zhuhai captain Liu Mu Qiang will fly the day's first trip. But before they can start the Puma's engines, they must wait until 7:00 a.m., when the Chinese air traffic controllers begin work and can grant permission to depart. The bubbas board, buckle up, and cork their ears with yellow foam. Permission granted, two Turbomeca Makila 1A1 turboshaft engines a mere two feet overhead whine up to 30,000 rpm, which the transmission harnesses down to 265 rpm for the main rotor and 4,880 rpm for the tail rotor drive. Several Filipino bubbas make the sign of the cross.

We ascend at 1,000 feet per minute into a sky as thick as oatmeal. Captain Liu tells me that even on a clear day the air pollution is so bad you can't see the ground from 2,000 feet. The bubbas try to stare holes into the luminous gruel but end up falling asleep against the windows.

We fly for 90 minutes at 5,000 feet to the Lu Feng oil field, which lies 160 miles southeast of Hong Kong. The Lu Feng is a bead in the black gold necklace of Asian offshore oil reserves—reckoned in the billions of barrels—that stretches from Russia's Sakhalin Island to Indonesia. Because the route to the rig takes us through three ATC zones that don't talk to one another, Chase and Liu must pass themselves from one to the next and then radio back to the previous zone confirming their passage. During the flight they switch back and forth among three radios, speaking Chinese to the controllers in Shenzhen and English to the controllers in Hong Kong.

During one brief break, Chase tells me over the intercom that most of the flying he does off the coast of China is on instruments. "ATC keeps us between 5,000 and 7,000 feet, and most of the year this is what you see," he says as he points out the windshield, which might as well be shrouded in gauze. "You trust the autopilot. You trust your mechanics and spark chaser [an electronics technician]."

Chase has been flying the Puma in these kinds of conditions for more than a year. After the ERA-Zhuhai venture had won contracts to service offshore rigs owned by Amoco Orient and Australia's BHP, ERA's managers had to get the Puma to its new home. They considered shipping it by boat across the Pacific but then figured it was cheaper and probably safer to fly it. On August 6, 1994, Chase and four crewmates—Chinese pilots Wu Zhong Qian and Liu Mu Qiang, Russian navigator Pavel Latsenko, and ERA mechanic

ERA mechanics Scott Garrett (left) and Carey Henry (right), along with electronics technician Jim Johnson (center), work long hours to keep the Puma purring.



Dave Ownby—began the 5,000-mile journey.

Just before leaving, Chase removed several panels from inside the Puma's cabin and stashed \$20,000 in cash to cover the cost of fuel and other expenses. He figured the universal acceptance of greenbacks would smooth the way for making purchases. "Really our only defense against uncertainty on that trip was cash," he says.

After leaving Anchorage, Chase and company flew up to Nome, across the Bering Sea, over eastern Russia, and then down into China. On the way, the

polyglot Puma crew spoke freely with some of the former Soviet ATC people who watched Korean Airlines flight 007 disappear from their screen in 1983. "Things change," says Chase. "Things are changing for the better, wouldn't you say?"

One thing that hasn't improved, the Puma crew found, was the difficulty of arranging a trip through foreign lands. Before setting out, they applied for an entry permit from the Chinese government and filed flight plans with the U.S. Department of State and the Russian Department of Transportation in Moscow. Fortunately, crewman Pavel Latsenko could interpret instructions from the Russian ATC and weather service and negotiate their needs at the seven Russian airports where they refueled. They frequently encountered

difficulties.

"In Russia there are airports where you can't buy food, hotels don't exist, and the water is opaque," says Chase, "but they'll let you sleep in the terminal building." And every Russian airport seemed to charge a different rate for its services. "We had to make sure we personally paid every entity that wanted money," says Chase. "You can't just leave a pile of cash in a general manager's office, but you pay him for landing and parking. We went to the air traffic people and paid them, then to the weather reporting people, and to

the fuel boss, but you had to make sure you didn't miss anybody and that everyone was happy." The crew was pleased to discover that the airports in China are a good 20 years ahead of the ones in Russia.

On today's flight over the South China Sea, the oil rig's radio operator finally tells us to descend for our approach. We break out of the clouds, sandwiched between their massive bulk and endless ranks of white-caps 400 feet below. Perhaps a mile away looms the biggest, most ungainly object I've ever seen on the ocean: a Falcon-class semi-submersible exploratory rig. As the giant platform rocks on its pontoons, the derrick's crown block, some 30 stories above the ocean surface, sweeps a 125-foot arc through the sky's underbelly like an enormous metronome.

At each of its four corners, the Falcon has a set of dynamic thrusters, or propellers, which churn the sea into a turquoise froth all around its periphery. Guided by a global positioning system, the thrusters attempt to keep the



At the Shenzhen Airport Hotel, ERA's employees can hang their hats and play a game of billiards.

rig stationed over the appointed drilling site. The Falcon, which is operated by BHP of Australia, had sailed in the day before from Singapore, and though six of its eight 45,000-pound anchors have been dropped, their chains have not yet been tightened with a winch; consequently, the rig rocks mightily at the whim of the high seas.

The rig's main platform is as big as a city block. The main deck supports, eight cross-braced steel columns the size of Nebraska grain silos, are welded to two massive pontoons that look like flat-topped submarines—which

they are. When a semi-submersible rig is ready to begin harvesting oil, the crew floods the pontoons until they reach neutral buoyancy 55 feet beneath the ocean's surface. The rig then floats steadier, uninfluenced by wave motion. In a sea of 40-foot swells, with pontoons submerged and anchors tightened, the rig

rolls and pitches only a few degrees. That maintains stability for the drill stem—the steel pipe that bores deep into the ocean floor.

Jutting over the rig's bow seven stories above the water, the 80-foot-square helideck is rising and falling 15 feet every 10 seconds or so. The Puma is 61 feet long from the tip of its main rotor to the tip of the tail rotor, about as long and tall as a tractor-trailer, and the ledge we are to land on looks like it was designed for poker games. Chase puts the Puma in a descending spiral from a quarter-mile out, and immediately the rig's two crane operators lower their booms to clear the airspace and reduce the possibility that the helicopter will collide with the rig. A support ship



steams toward the Falcon, large waves breaking over its bow. Dwarfed by the rig, the 140-foot vessel stands by to pick up survivors in case the Puma goes down.

Chase swings the helicopter around to the platform's leeward side for an approach into the wind. "They're pretty high out of the water," he says over the intercom. "They're not drilling yet. Quite a bit of movement. They're not ballasted down yet." As the Puma descends, the tension rises and Chase spits out an expletive. "Look at that," he says. "They've put up some damn towers, some radio antennas on that corner of the helideck. Okay, we'll have to slide in to the right."

Chase, who has more than 10,000 hours in helicopters, has made more landings on the restless helidecks of these offshore platforms than he can count. He has flown to North Sea rigs off England and the Netherlands, as well as Greece, Central and South America, Africa, Russia,



and Canada. He landed on this very platform 10 years ago when it was stationed off California outside of Santa Barbara, and then a few years later after it moved to the waters surrounding Alaska's Kenai Peninsula. "The trick is to get down on the deck when it's at its apex," he told me later. "You absolutely don't want to meet it on its way up. That would really load the G forces on our landing gear. That could hurt us."

The oil rig landing officer, a stout fellow in a red windbreaker, waves his arms broadly from the helideck's in-board edge. He's not signalling the pilots; rather, his arm movements are reactions to the rig's pitches and rolls. Chase matches the undulations of the deck as he side-slips the Puma above it, touches the deck as it crests, and

The Shenzhen Airport, built three years ago, is part of the expansion of cities bordering Hong Kong. The farmland surrounding the airport (left) is rapidly disappearing, making way for airport sculpture gardens (above).

sinks into the next trough as part of the rig. He turns off the landing lights, an all-clear signal to the landing officer, who staggers up, grabs the sliding door, and rolls it open. Humid gusts buffet the bubbas as they hit the deck.

Immediately Chase begins to tie the helicopter down while Liu goes through the shut-down procedure. The top-heavy Puma can handle landings on 10-degree slopes and shut-downs on eight degrees; momentarily, the pitching platform reaches those limits. While Chase secures the Puma, his 15 passengers lurch across the deck until they grab the handrail that leads down to the crew quarters.

The creaking accommodations below deck reek of fresh paint and fried chicken. The new arrivals, who are beginning a 28-day tour, complete the rig's complement of 86 workers. They totter down the narrow corridor, shouldering walls until they get to the TV room. There, they are assigned to lifeboats. A few

minutes later, Chase and Liu, still wearing life vests, show a bilingual video that explains Puma safety procedures to everyone who will be returning to shore that day. The more seasoned-looking bubbas watch intently. A grizzled, hard-bellied man sitting next to me confides that anyone who's been in this business 20 years knows a few stories about choppers disappearing into the ocean.

On his way back up to the helideck, Chase returns an empty mug to the galley, and a Brazilian cook gives him a tin of freshly baked cookies. He loads his sole returning passenger's baggage—and the cookies—through the rear cargo door, while Liu, command pilot for the return trip, runs down the startup checklist. We are standing just a few steps away from the edge of the platform when Chase informs me that the most dangerous part of the job is getting back in the air from the helideck. But the Puma, he says, is the best helicopter he has ever flown for offshore work.

"Landing in 40-knot [46-mph] winds

is normal—we'll fly Pumas in 70-knot [80-mph] winds in an emergency," says Chase. "A clean wind across the helideck is no big deal. But wind coming through the structures on the rig creates a lot of turbulence. You get dead air and need a powerful aircraft for those landings and takeoffs. That's why the Puma is so popular for this work."

A few minutes later Chase prepares to head back to Shenzhen. I have climbed the derrick—perhaps seven stories above the helideck—and from my perch Chase's liftoff looks stately, the Puma's smooth departure emphasizing the massive heave of the rig. The red, black, and white helicopter rises, quickly vanishing into the clouds.

When it comes to providing a lifeline to their rigs, many oil companies insist on the Puma, which is derived from Aérospatiale's original SA 330 Puma. The prototype for the new Puma first flew on September 13, 1978, boasting upgraded engines, an improved transmission, and a new high-energy-absorbing landing gear. Because the new Puma required less maintenance and

offered reduced cabin noise and better crash survivability, it attracted both civilian and military buyers (specially outfitted Pumas have been purchased by the French army and by the air forces of Sweden, Spain, and Brazil). And besides carrying passengers, it can deliver critical cargo faster than ships can.

Oil companies also use helicopters to provide 24-hour medical evacuation standby. For its rigs in the South China Sea, BHP calls for complete evacuation whenever a typhoon draws within 250 miles. "We don't wait that long," says Chase. "When a typhoon or tropical depression is building out there and we're not sure we're going to evacuate, we fly a couple of loads, maybe 30 non-essential people anyway, so if the evac becomes necessary, we can completely evacuate the rig in three more three-hour round trips."

Western oil companies have their own aviation safety inspectors, who investigate the records of every serious bidder on offshore contracts. That was one reason Zhuhai wanted an American partner. Mike Carroll, who alter-

nates with Chase as ERA's lead pilot in China, told me, "Their record-keeping on their aircraft didn't conform to Western standards and they lost some contracts because of that."

"Worse still," he confides, "Zhuhai lost face." Though the company had the best safety record for helicopter operators in China, its maintenance records were not on a par with those of U.S. companies. Even the pilots' catechism of checklists was not routine in China until recently. "Our startups," concedes Captain Wu, "were done by memory."

Carroll, who, like all the ERA people, has come to appreciate the Chinese custom of saving face, soft-pedals their style of record-keeping. "If the FAA didn't require all that stuff, we probably wouldn't bother either," he says. "As far as the flying goes, they're better than many of the American pilots I've flown with."

Immediately after the Puma lands, Zhuhai pilot Liu Mu Qiang ties it down to keep it from rolling around on the deck.





Should the need ever arise, the rig's 86 workers could escape in two 50-person lifeboats (left, at center), which are built to withstand high seas.

For mechanic Carey Henry (below), a good paycheck is the lure that makes working thousands of miles away from home worth it.

and alphabet for more than five years, are fluent in the lexicon of flight, and punctuate their conversational lapses with quiet laughter. In the early 1980s they began flying helicopters for a civilian outfit in which the pilots receive free training and can be conscripted in the event of war.

Having flown Pumas and Bells in Alaska, Florida, Australia, and Singapore, Wu and Liu understand how regulations governing flight in China frustrate Westerners. For generations China has been run like a vast penal camp, and movement is still tightly controlled. If a helicopter crew wishes to hover for, say, an engine check, it must file a flight plan 24 hours in advance. China's ATC dictates specific altitudes; hunting for better winds or visibility is usually not permitted. "Compared to the States, where you could fly around all your life under 1,200 feet without talking to anyone or ever filing a flight plan, China is pretty restrictive," says Chase.

"In China," Liu explains ingenuously, "decision-making in the cockpit is discouraged."

Chase, who is always ready to defend the self-effacing sentiments of the Chinese, jokes: "Nothing wrong with rigidity. I've known pilots who think that indecision is the key to flexibility."

Our Chinese colleagues don't have much to learn from us about flying. If it's just the two of us on the intercom and we screw up, we acknowledge it and move on. But in a group of pilots or airline staffers we keep a sense of humor and reserve criticism. They get down on themselves more than I would anyway." Carroll glances fondly at Wu and Liu. "Look at what they're doing, taking on a new helicopter in a second language they've studied informally for a few years. We all admire them and have to wonder if we could do it."

Wu and Liu began their flying careers more than 20 years ago in the northern China grain belt, flying the Chinese version of the Russian Antonov An-2 biplane. "We were crop dusters," says Liu, and Wu adds, "We were parachuting." They confer in Chinese and laugh; "Not same day," Liu explains. Both men have studied the English language





The helideck safety officer, known to his co-workers as Freddie, oversees all activity surrounding the helicopters that service his rig. It's his job to ensure that aircrews unloading supplies (below) don't walk where they shouldn't, and that the deck is clear before a helicopter takes off (right).

Back at ERA's office in the China Southern Airlines Hotel, Chase allows that the flight we just completed was a little hairy, but typical for one to an off-shore rig. All eight people in the small room are smoking. Joe Porter, a Puma pilot, hacks theatrically and opens the window, gruffly suggesting that the introduction of fresh air could make everyone hyperventilate. He lights up a cigarette and moves in on the cookies that Chase scored out on the rig. "I've been here too long," he says, simultaneously eating cookies and smoking.

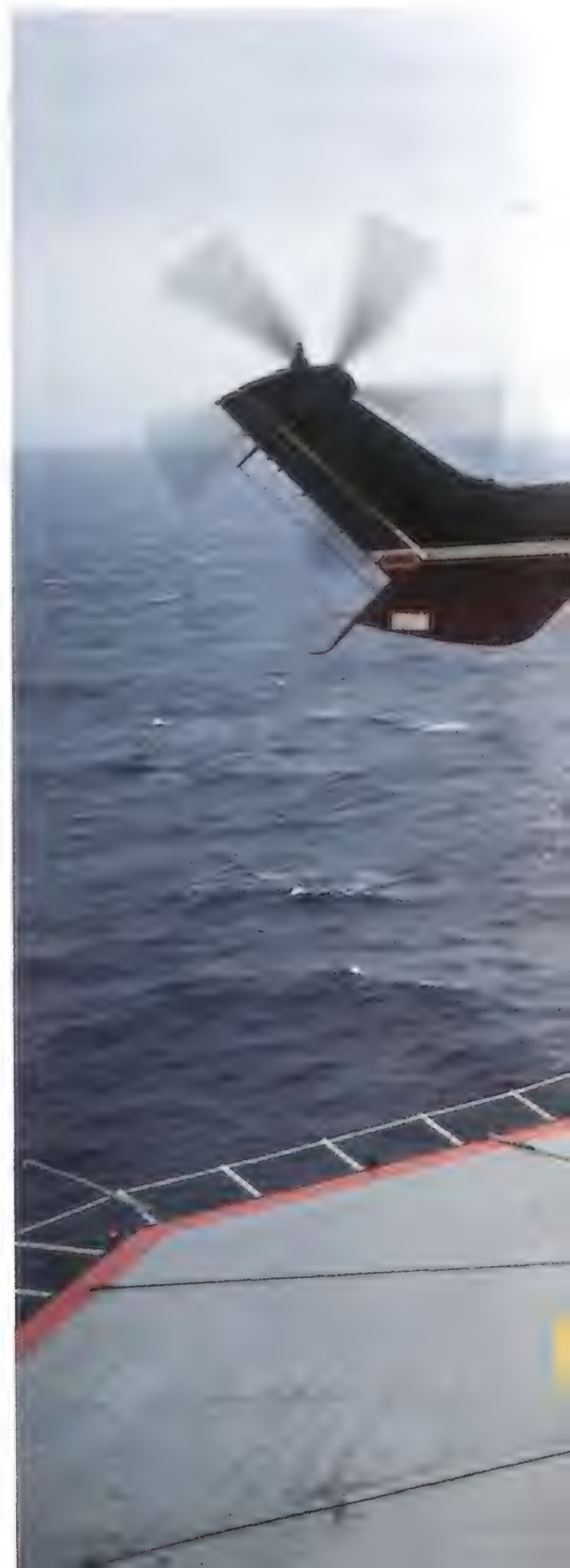
"I've quit dreaming about sex and started dreaming about hamburgers." A self-styled iconoclast, Porter says that flights to oil rigs are never that "hairy." He says that the job is nothing more than glorified bus driving.

Loren McCoy, who arrived that morning from Anchorage to relieve Porter, tries to quiet him, but Porter is on a roll. "The flying here is no better or worse than any other place in the world," he says. "The North Sea everyone thinks is so dangerous—that's a bunch of baloney. We have visibility minimums and maximum winds, and we don't fly when it's not safe." Then, tempering his disaffection somewhat, Porter says, "The real Puma gods are the mechanics and the spark chaser. For every hour we fly the Puma, they put ten in getting it ready for the next ride." Scott Garrett and Carey Henry, the mechanics, and Jim Johnson, the spark chaser, collectively regard Porter with their heads propped against the back of the black vinyl couch and quietly blow more smoke.

None of the pilots or mechanics that live this peripatetic life claim to do it for love of travel or even an active curiosity about other cultures. "The money's good," says Chase, to which Porter adds, "Yeah, if less than half of what a senior airline pilot earns is good enough."

It must be: The profession these men

have chosen has its frustrations and inconveniences. They spend half their lives in hotel rooms or in smoky hotel-room-size offices "keeping all the balls in the air"—everything from making courtesy calls to government officials to locating a source for replacing their stolen bicycles. They work the phone tortuously, handicapped as monolingual Americans who can't afford misunderstandings when filing flight plans with the Shenzhen ATC. They spend much more time doing paperwork than flying. They eat junk food, fried food,



and mystery food. They wash their clothes in the hotel bathtub (if it has one) and may go for weeks with no more entertainment than playing chess against the office computer or feeding the rat that lives behind the toolshed on the ramp, hoping he doesn't chew a hole in one of the Puma's external life rafts.

When Porter demythologizes their work, no one minds, maybe because they understand how it feels to be away from home for seven weeks at a time or maybe because they recognize some

grain of truth. But Liu and Wu, who both have more than 1,000 hours in fixed-wing aircraft, say they'd never want to quit flying rotorcraft. They say the real bus driving is flying from airport to airport. Everyone senses the set-up for some face-saving here, and the conversation does a touch-and-go on the peevish Porter's theme, then shifts to a discussion of a helicopter's freedom to land just about anywhere.

Talking shop, when the shop is the sky, is a prominent part of the downtime for people who fly only 50 hours

in a busy month. They talk of ERA pilot Ron Smith's 19 rescues of people on Mt. McKinley. Stories of Bering Sea rescues and mercy flights abound. Wu and Liu nod and laugh at the right times, understanding the spirit of the moment if not the nuance. With three years to go on this joint venture and tacit assurance of more to come, it's possible that before long, Mike Chase will begin a story: "Ever tell you about the time me and old Wu were flying the Puma in a typhoon evac out in the South China Sea..." —



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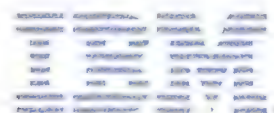
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THE BIG 10:

Counting Down the Winners

Airplanes whose
years in production
qualify them for the
all-time top-10 list.

by Dee Mosteller

Aviation is less than 100 years old, but in that time it has progressed from a first awkward step to a triumphant leap into space. Along the way, hundreds of types of airplanes have been designed and built. Some are barely footnotes in this brief history, but others are milestones. A very few have been in production for exceptionally long periods, making up a select group marked by unique staying power in an industry that almost reflexively replaces the obsolete. A handful of airplanes, in fact, has been in production for half the history of this young industry—nearly 50 years.

The following survey of enduring, classic airplanes includes everything from a single-engine light airplane to a four-engine bomber, a rag-wing tail dragger, and a razor-wing fighter. They're not all beauties, though in this business that was never a guarantee of survival (see "Lovely Losers," June/July 1992); they may

not have been produced in the greatest numbers; and they're not all regarded as the best in their niches. But all share some intangible quality that sets them apart, a quality that kept them in demand longer than any other airplanes ever built.

—The Editors

The Formula

We began by counting the numbers of a given type that had been produced over the years, but precise production numbers are elusive and hard to confirm—even impossible in some cases. Then we realized that another criterion is equally indicative of an airplane's durability—the number of years it was in continuous production—and it's also more straightforward to resolve.

But the search was still difficult, as sources disagreed on the years when production started and ended, sometimes significantly. We went to the primary source—the manufacturer—wherever possible, but many could not corroborate the dates. Data on former Soviet-bloc aircraft was particularly difficult to interpret, and for this information, we are very grateful for the assistance of Irina Kuznetsova and Lev Vorobiov, the latter a former military test pilot who dug through Russian archives at Monino, near Moscow.

Even the term "production run" was problematic. When did production really

begin—when a prototype was built? The year of first flight? Many airplanes made that maiden voyage years before an assembly line was established. The definition we finally settled on is the year that metal was first cut for an airplane that ultimately would be delivered to a customer, through the year that the last airplane was assembled for delivery.

It was also difficult to define what constitutes a single model. The type certificate, the piece of paper that defines the model to the Federal Aviation Administration, was little help. Almost all aircraft are upgraded in an effort to stay alive in the market, and though some of the changes are merely cosmetic, others are more significant but leave the basic airframe unaltered: A tail is enlarged or a fuselage stretched, engines gain power, and structures are beefed up to withstand increased loads.

Some airplanes are replaced by totally different ones bearing the same or similar names. Still others change their names but retain the original type certificate. For our purposes, we focused on production line

tooling. If an upgraded model is produced on the same line, is built with mostly the same tooling, and has basically the same airframe, we considered it the same airplane. In the cases of older airplanes, where the record is unclear, we had to rely on the manufacturer's word.

As for the "continuous" part, almost all airplanes have had at least one hiatus in their production lives. Companies are merged or sold. Airplanes are put on hold. Depressions and recessions, market shifts, glitches, even war—all can halt the production of airplanes. After grappling with the definition, we decided to define a work stoppage of one year or longer as a break in continuous production.

We could not absolutely confirm all of the numbers, but this list represents a best effort, based on current information. Most of the airplanes that made the top 10 are still being produced, if not by their original makers then by someone else, often in another country. Next year the list will be different, as those still in production surpass those that finally surrender to change.

—Dee Mosteller



RUSSELL MUNSON

Piper Cherokee PA-28
35 Years
(1961–ongoing)

10

The Arrow, Archer, Challenger, Warrior, and Dakota, mounting 140-, 150-, 160-, 180-, 200-, and 235-horsepower engines, all have a single ancestor. They are all associated with the prodigious Piper PA-28 Cherokee single-engine, low-wing line. With buyers of trainers and personal airplanes beginning to demand metal construction, increased comfort, more sophisticated avionics, and better performance, Piper introduced the first Cherokee, the four-place C model, in 1961. The more powerful Cherokee 235 followed in 1963, and the less expensive two-seat Cherokee 140 in 1964. The retractable-gear Arrow came along in 1967 to round out a complement of relatively low-cost personal airplanes. After Piper got tossed about in corporate warfare, new model names proliferated: Challenger, Archer, Warrior, Dakota, and turbocharged versions of both the Dakota and the Arrow. Today, the Cherokee line has been pared down to the Warrior III, Archer III, and Arrow 201. The line, though diminished, has survived many tests in a decimated general aviation market, with Piper being in or on the verge of bankruptcy more than once over the last two decades. Cherokees are uncomplicated, and they fly nice, look nice, and pretty much do what they're told. And with the Piper Cub as a cousin, maybe some of the magic rubbed off.

KATSUHIKO TORI NAGA CHECK SIX



CHECK SIX





Tupolev Tu-95
36 years (1954-1990)

8
(tie)

its graceful lines, swept wings, and slender fuselage belie its formidable capabilities and mission. Tupolev designed the "Bear" (its NATO designation) during the cold war as a threatening medium-to-long-range strategic bomber, missile carrier, and reconnaissance platform. With four husky 14,795-shaft-horsepower Kuznetsov turboprop engines, the Tu-95 flies high, fast, and far, with a crew of seven to nine and a payload capacity exceeding 28,000 pounds. The Tu-95 is loaded for bear, carrying nu-

merous combinations of missiles and guns. It has gone through many transformations and has even served as the testbed for work on nuclear aircraft engines. Russian archives say the Bear went out of production in 1990 but may have been briefly reborn in 1992, when Ukraine reportedly started to build it again (though this has not been confirmed in the West). Outside the Soviet Union, Tu-95s were operated only by India. In post-Soviet Russia, nothing has come along to replace the Bear in the long-range strategic reconnaissance and maritime roles. The most recent derivative is the Tu-142, an anti-submarine patrol aircraft.

8 (tie)

Pilatus PC-6
Turbo Porter
36 years
(1960-ongoing)

Long of snoot, boxy of body, and square of wing, the single-engine PC-6 Turbo Porter has been called everything from a "jeep with wings" to "dog ugly."

A true short-takeoff-and-landing utility aircraft, it can take off in 650 feet and land in 417, carrying either 11 people or cargo weighing as much as the empty airplane itself. The Porter started life in Stans, Switzerland, with a 340-hp Lycoming engine, and within two years had made the switch to a 523-shaft-horsepower Turbomeca turboprop, which was replaced, in turn, by the reliable Pratt & Whitney PT6. The Porter has never been out of production, but it rolls out at a leisurely pace (currently about two per month). Fairchild Aircraft built it briefly under license, and civilian and military users in 54 countries have bought a total of slightly over 500. Like many of the aircraft on this list, the Porter has taken on a wide variety of roles: airline and troop transport, ag-plane, primo parachute club vehicle, close combat support, air ambulance, target and glider towing, rain-making, search-and-rescue, aerial survey, and clandestine missions for the CIA's Air America. On wheels, skies, or floats, the PC-6 is a master of hostile environments. It has operated out of 650-foot openings in jungles, and off glaciers and sand dunes. It has endured because it does what is required of it with minimal fuss. It is rugged, simple, reliable, and relatively cheap to run and maintain. Its performance and operational costs make it competitive with helicopters, and its recently slashed price hasn't hurt either.

GEORGE HALL/CHECK SIX



6 (tie)

Boeing 707/AWACS
37 years (1955-1991)

As a transport aircraft and the United States' first contribution to the Jet Age, the 707 was produced for 24 years, putting it well behind the Douglas DC-9/MD-80 (33 years), Boeing 737 (31), Boeing 747 (30), and Fokker F-27 (29) in the airliner category. But as soon as the 707 airliner stopped coming off the production line, the 707 E-3 platform for the Airborne Warning and Control System (AWACS) version started rolling, continuing for another 13 years and about 1,000 airplanes. The first in the dominating line of Boeing commercial jets, the 707 was a derivative of the Model 367-80, which served for 18 years as a testbed for many airliner innovations (this famous prototype, "Dash 80," currently resides at Boeing's Seattle headquarters, where it was recently restored). With its sleek lines, swept wings, greater-than-600-mph speed, 180-passenger capacity, and 3,000-mile range, the 707 set the standards for jet transportation. Subsequent airliners, not just Boeing's, incorporated many of its features, including passenger entry doors on the port side at each end of the cabin and a configuration that placed passengers on the upper deck and cargo below. It was also the first in the era of big-bucks airliners. The first model, produced in 1955, cost approximately \$4.3 million; the last, delivered in 1982, went for

\$15 million. Later models included a short body for Australia, intercontinental versions with a 6,100-mile range, and a passenger/cargo convertible. The 707 received a wider body in 1956 and flew as the KC-135 tanker/transport for the U.S. Air Force until 1965 (though Boeing does not consider this the same airplane as the 707). The 707s endured because they were first, and because they were rugged, safe, all-purpose people and cargo movers, flown by dozens of airlines the world over, often for more than 20 years. In 1985 Grumman won a contract to convert a 707 into the Joint Surveillance Target Attack Radar System, also known as the E-8C or J-STARS. This battlefield radar aircraft debuted in the Gulf war before testing was complete and performed masterfully.





Mikoyan-Gurevich
MiG-21
37 years
(1959–ongoing)

6
(tie)

The infamous MiG-21 single-engine, single-seat, delta-wing, Mach 2 fighter, also known to NATO nations as "Fishbed," was developed for the Soviet Air Force

as a mass-produced, short-range fighter and high-altitude interceptor for which fuel consumption and endurance were of little importance. Emphasis was on acceleration, climb, and high supersonic capability, and later versions could achieve Mach 2.35 while carrying two K-13 Atoll missiles. Designed to pull a maximum 7 Gs, the original MiG-21 could fly for only one hour and 43 minutes, or about 875 miles in still air. One of the most successful and respected fighters of all time, the MiG-21 was built in Russia until 1985. China picked up a license and began to build the airplane as the Chengdu J-7 in 1964; the Chinese still produce and sell it as the CAC J-7. It has also been built in Czechoslovakia as the CS-106 and in India as the Type 74. Total production figures for the various models are virtually impossible to determine; however, it is thought that more than 10,000 have been delivered. The MiG-21 has fought for many countries, sometimes on both sides of a war, and recently modernized -21s should soldier on for years. Why has it endured when better fighters have gone the way of Hula Hoops? Possibly because of the relatively low cost to manufacture it, coupled with the relatively high cost of developing a replacement.



5

Lockheed C-130 Hercules 42 years (1954–ongoing)

Fat, frumpy, and forty-something, the Lockheed C-130 Hercules is one of the best known and most used of all tactical transport and multi-mission airplanes. The Herky-bird's many names, most of them drawing on its unique appearance, varied functions, and merits, include Snoopy, Fat Albert, Pinocchio Nose, Ski-bird, Vomit Comet, Eagle Owl, and Rhinoceros. The basic airframe, which can carry more than half its weight in payload, has evolved into more than 70 versions. Powered by four Allison turboprop engines, the C-130 has been used in more than 60 countries for military and civilian passenger and cargo transport, meteorological research, firefighting, pest control,

fertilizing, aerial mapping, communications jamming, aerial reconnaissance, search-and-rescue/recovery, aerial refueling, dropping paratroopers, drone launch and recovery, humanitarian relief missions, oil spill cleanup, zero-G training, and anti-drug-smuggling

operations. It has been used as a flying TV station, a bomber, and a gunship, and has appeared in every U.S. military operation since the Korean war. Specially equipped C-130s dropped relief supplies into Bosnia early in that civil war, then became troop transports when U.S. forces deployed to keep the peace. Herks have landed on dirt strips, unimproved fields, jungle clearings, snow, glaciers, and once even an aircraft carrier (note: you can download video of the carrier landing by accessing the Air & Space Web site at <http://www.airspacemag.com/>). On its final run hauling refugees out of Vietnam at the end of that war, one C-130 carried 456 people, among them Tim Nguyen, who was so happy to escape that he vowed he would go to work for the airplane's manufacturer. Recently, the young engineer was named Hercules Employee of the Year in Marietta, Georgia. When Kelly Johnson of Skunk Works fame first saw the plane for the C-130, he said, "It's a pretty good design, but you won't sell more than a hundred of them." By early 1995, 2,100 had been delivered, and the newest version (the C-130J) was scheduled to be delivered to the United Kingdom's Royal Air Force. The mighty Hercules has endured, to fans say, because of its straightforward, simple, rugged design. It is so rugged, in fact, that the first production airplane is still flying with the 71st Special Operations Reserve group at Hurlburt Field, Florida.



RANDY HOLLY



4

Piper Cub 46 years (1937-1982)

To most people outside the aviation business, anything without jet engines and 100 passengers is a Piper Cub. This widespread state of innocence speaks well for the brilliant marketing job William T. Piper and company did after World War II—as do the nearly 37,000 Pipers sold. Production of Piper Cubs started in 1937, when the first model J-3 rolled out of the Lock Haven, Pennsylvania factory sporting distinctive “Cub yellow” paint with a black stripe down the fuselage. Its high wing, fabric covering, low power (40 hp), and low weight (635 pounds empty) made the tandem two-seat J-3 a mighty force in a small package. Literally sold door to door like vacuum cleaners on the premises that every home needed

one, the J-3 spawned a number of famous offspring, including the World War II Army L-4 and the Cub Special. In 1949 the J-3 achieved “Super” status when it was upgraded to incorporate partial metal construction in place of some of its fabric, a beefed-up airframe, and a 90-hp engine. The Super Cub grew into a DeLuxe model with 150 horses and continued to be sold until 1982 as a utility airplane for flying clubs, pipeline patrol, agriculture and pest control spraying, training, and even aerobatics. When the Piper company began changing hands as fast as a Las Vegas crookier can deal, the venerable Cub went out of production. The Super Cub returned in 1988, departed in 1990, and reappeared from 1991 to 1994. Today, a new Piper is emerging from bankruptcy, and the Super Cub is still in mothballs. But the tooling is there, just waiting.





3

Antonov An-2 47 years (1949–ongoing)

If ever an airplane was born struggling for survival, it was the Antonov An-2. Even in 1949, this tail-dragging, single-engine biplane was an anachronism in a world of increasingly sleek, tricycle-gear monoplanes. Survive it did, however, to become possibly the biggest selling, longest-lived transport in the world. Manufacture began in Russia in 1949, but the 14-seat mini-airliner continued in production in Poland as the PZL Mielec An-2 Antek. Production continues today in China, where the An-2 became the SAMC Y-5B, an agricultural model. More than 36,000 of these aeronautical oddities have been built, and they've been used for just about everything. Military and commercial passenger transport, cargo hauling, marine biology research, paratrooper operations, ag-plane, airshow attraction—the An-2 has done it all, on land and on water. In recent years a few have even come to the United States, mostly as curiosities. With its bruising 1,000-hp radial engine, wide body (almost the same width as a DC-3), and SiOL characteristics, the An-2/Y-5B is an airplane for all seasons, from Mongolia to North America.

Why Some Favorites Didn't Make It

There are a number of surprises, not only among those airplanes that made the list but also among those that didn't. Hundreds of well-known airplanes fell short of the mark, and many that sold in huge numbers didn't make the list because their production runs, while intense, were all too brief.

The Douglas DC-3 may be the mother of modern airliners—more than 10,000 of these civilian craft and their military derivatives, the C-47s, were built, but it was in production for only 11 years. Douglas tried a postwar upgrade called the Super DC-3, but Convair took the twin market away. Aeronca's Champion was built for many years, but it was out of production as much as it was in.

The Messerschmitt Bf 109, one of the best known and most prolific of all fighters—more than 33,000 built—was in production for only 16 or 22 years, depending on which source you believe. In fact, nearly all of the famous World War II warplanes—Supermarine Spitfire, North American P-51 and T-6/SNJ Texan, Focke-Wulf Fw 190, Convair B-24 Liberator, and Republic P-47—were built in great quantities but used up like Kleenex.

The nearly-made-its and also-rans include many meritorious airplanes. The Beech Model 18, the first truly mass-produced



MD-80

“corporate” airplane, came close, with 34 years of nonstop production and about 7,000 delivered. The DC-9 and its successor, the MD-80/90, meet our rule for continuity, sharing a single type certificate as well as the same production lines and tooling, albeit with stretches and other modifications. Production on the DC-9 began in 1963, and the MD-80/90 is still going, making it the champ among airliners. (Interestingly, one group at McDonnell Douglas says it is not the same plane; another says it is. In fact, a DC-9-Super 80 came out two years before its model name was changed to MD-80 following the merger of Douglas with McDonnell.) The Raytheon/Beech Hawker 800 turns out to be the senior bizjet. Through four ownership changes, beginning with de Havilland (it was the DH-125 then), it has never been out of production for more than a year since 1963.

Other classic designs that one wishes were here include the Learjet, which has been produced for 31 years and beats all other business jets in numbers produced (nearly 2,000). When the Mooney Mark 20 series started rolling off the line in 1955, it was a revolutionary personal airplane—small, fast, and cheap. A Mark 20 model is still being made by the same company (and still in Kerrville, Texas); however, hard times in 1971 shut the Mooney lines down for two years. Thus, the Mark 20, which has been built for 37 years, did not meet the criterion. The Cessna 172, one of the most popular of all airplanes (nearly 37,000 have been built, and production will restart soon), and its forerunner, the 170, combined would have been in the top 10. But Cessna Aircraft Company said they were not the same airplane, and not built on the same production lines. Manufacture of the 172 started in 1955, but production was terminated when the general aviation market collapsed in 1986.

There were others that we recall with affection, like the legendary de Havilland Tiger Moth, the whimsical Avro Anson—a twin that outlasted most other military trainers in its class—and the valiant Ilyushin Il-2 Stormovik series, of which 37,000 were built, but not over a long enough period of time. And then there was the wispy little Breguet-19, a two-seat biplane built from 1921 to 1934, the world's first true military bomber.

Remarkable, enduring airplanes all.



Raytheon/Beech Hawker 800

PHILIP MAKANNA



1 (tie)

Yakovlev Yak-18
49 years
(1947-ongoing)

It may not be as pretty as its co-winner, but the Yakovlev Yak-18 is robust enough to handle unrestricted ac-

robatic maneuvers and reliable enough to train pilots. The Yak-18 story started in 1947 with an order from the Soviet Air Force, and 49 years later this one/two-place single-engine monoplane is still a standard basic trainer for military and civilian flying clubs throughout the former Soviet and Communist bloc countries. The Yak-18 has gone through many transitions, including a move from tailwheel to tricycle gear, various canopy arrangements, engines with up to 300 hp, and finally a redesigned cabin with three/four-place seating. A total of 6,630 have been built, and the Yak-18 is likely to keep on coming off the assembly line, slowly but surely, on the theory that it is simpler and more economical to keep an aircraft in production as long as it meets a need.

GEORGE HALL/CHECK SIX



Beechcraft Bonanza 49 years (1947-ongoing)

Walter Beech foresaw the inevitability of all-metal construction in 1947 when he introduced an innovative flying machine, a fast, sleek, four-seat, single-engine craft for the modern private traveler. Beech gave it the upbeat name "Bonanza," along with a unique feature that made it recog-

nizable: its classic Y tail. The original Model 35 series was produced from 1947 to 1982, which would give it a place among the top 10 all by itself. But the Bonanza didn't



stop there. It was the basis for a number of other models, including the T-34 military trainer, and a cheaper straight-tail version, the Model 33, which debuted in 1973 as the Debonair. The Model 33 is still in production, but under the name Bonanza, which is what it really is. The Model 35 was replaced in 1982 by the Model 36, a four/six-seat business/utility airplane that is currently produced in two versions, one with a turbocharged engine. By the end of 1995 a total of about 17,200 Bonanzas had been delivered. The Bonanza is a workhorse used widely for *ab initio* airline pilot training and charter work. But the airplane has endured because it is also handsome, fast, well built, and prestigious. It is the business professionals' choice (especially, as hangar lore has it, among doctors), and since it first hit the market, Beech has successfully fostered the "limousine of the air" image that has kept buyers coming back.

MIKE FIZER



1996 Motor Trend Caravan



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Always wear your seat belt.

When Germany surrendered in 1945, Joachim Foellbach was a young engineer with the Siebel aircraft factory. Although Siebel's main contribution to the war effort had been the licensed manufacture of Junkers Ju 88 bombers, at war's end Foellbach was working on advanced experimental projects that would prove very interesting to the Soviet forces that came to occupy Halle. As a result, Foellbach would experience personally the capricious policies with which the Soviet Union managed its zone of occupation.

Like the other Allied victors, the Soviets co-opted German designers and engineers for the development of their own aerospace industry. But the Soviets alternately starved and rewarded the Germans, first imprisoning them in the Russian hinterlands, then returning them to their own country to build what was intended to be a new, world-class commercial airliner.



Under the inconstant patronage of the Soviet Union, the warplane builders of the Third Reich reached for their former glory.

by Fred Stahl

Color photographs by Mark Simon

"It was the biggest madness imaginable," Foellbach told me not long ago. "[The East German communist leadership] wanted this small country, so wretched and shabby after the war, to be just like before, with a magnificent aircraft industry." I spoke to Foellbach in Munich in 1993, almost half a century after the events he described took place. He derided the postwar political folly, but he was speaking with the benefit of hindsight. In the 1950s, when he and thousands of other workers came to a factory outside Dresden, they were caught up in the dream. Working with a single-minded intensity reminiscent of war production, the East Germans built a four-engine jet airliner, the Model 152, and flew it in 1959, less than five years after they had begun work. Their goal had been to produce an airliner that could compete with the new jet aircraft just beginning to fly in the West. Had the Soviets been steadier patrons—or had the Germans won control of their designs a few years earlier—they might

The Rise and Fall of the East German Aircraft Industry

have pulled it off. Few in the West know how close they came. For three decades, the epic rise and fall of the East German aircraft industry lay under a cloak of silence.

While the United States was organizing the Marshall Plan to nurse western Germany back to health, the Soviets, who had lost 18 million lives to German aggression, exacted staggering war reparations from the east. Moscow took a quarter of the eastern zone's annual economic output and picked the country clean of everything of value, even the rails from the railroads. Perhaps the most valuable com-

The gate that once guarded a Nazi airfield (opposite) became the monumental entrance to a new aircraft industry. The East German state intended to prove the superiority of socialism with a single airliner—the Model 152 (below).

modity the Soviets took was German technical know-how. They had access to some of the most impressive aviation minds of the period, for Heinkel, Arado, Siebel, and Junkers all had factories in the east.

In Dessau the Soviet occupation force established a company headed by a Red Army lieutenant colonel to rebuild the Junkers aircraft factory and muster German engineers and mechanics for military research and development. A similar operation was put in place at Stassfurt for jet engines.

The German specialists in Dessau were ordered to write down everything they knew about the design, construction, and testing of aircraft and jet engines. They prepared 2,000 reports and shipped them to the Soviet Union. The Junkers engineers picked up where they had left off in developing medium-range jet bombers, and other aviation specialists were put to work at Siebel dismantling and packing up experimental aircraft, like the Model 346, a small rocket-pow-

COURTESY GUNTHER WEGENER





COURTESY FRED STAHN

ered aircraft that had been designed to fly at Mach 2.

Foellbach remembered that in the beginning the workers were not paid; instead, the Soviet minister for aviation sent shipments of food. But in the first of many abrupt reversals, the engineers began receiving good wages in April 1946. It looked as though their lives would return to something close to normal; at least they would have predictable incomes. Foellbach recalled signing a contract that said he might have to work in another city, but the Soviets assured everyone in Halle and Dessau they would remain in Germany.

Then, at 3 a.m. on October 22, 1946, Soviet soldiers with machine guns appeared simultaneously at the homes of selected aircraft specialists while trucks with more troops waited in the streets. "We were abducted by the Russians," said Foellbach. "We had four hours to gather up our belongings."

For two weeks they traveled across Eastern Europe on a train with no other passengers except Red Army guards—530 engineers, scientists, mechanics, and metal workers, bound for Podberez'ye, a small village 75 miles north of Moscow at the confluence of the Volga and Dubna rivers. Some men were allowed to take their families. Others were not. Some could take nothing; others could take furniture and anything else they might want. The lucky ones took food. Foellbach took only his personal possessions. His wife, children, and mother-in-law followed six months later with their furniture.

At Podberez'ye, in abandoned buildings the Soviets had filled with machinery scavenged from German aircraft manufacturers, the transplanted engineers continued to work on aircraft they had been developing when the war ended. Inside the factories, at least, it must have seemed like home.

Siebel's supersonic rocket plane was put through a test flight program, but the Junkers designs were the most in-

fluent. Toward the end of the war the Junkers engineers had been experimenting with wings swept both forward and aft to improve aerodynamic performance near Mach 1. They built the Ju 287, a multi-engine jet that flew in 1944, and a more sophisticated research aircraft, the EF (*Erprobungsflugzeug*, experimental aircraft) 131. With six jet engines in two clusters slung under its forward-swept wings, the EF 131 was to be a 50,000-pound bomber with a flight radius of 1,425 miles.

In Podberez'ye the Germans lived under the poorest conditions. Some families were lodged in unheated barracks adjacent to a German prisoner of war camp; others were put up in an unused school. When the Germans arrived in the village in November 1946, the ice on a nearby lake was already three

feet thick. That winter, temperatures went down to -40 degrees Fahrenheit at night. To warm their families, the men surreptitiously made small stoves in the aircraft factory and smuggled them home piece by piece—a dangerous business. One man got caught stealing 12 feet of wire to electrify his daughter's doll house and was sent to a camp in Kazakhstan. He was released after a year, but it took him another 12 months to make his way back to his family at Podberez'ye.

From 1946 through 1948, Soviet authorities sporadically



FRED STAHN

Almost 80 when he talked about his exile in Russia, Joachim Foellbach remembered the shabbiness of Podberez'ye. The Germans transplanted there were eventually allowed to retrieve furniture and other possessions from home (top).

gave cartons of food to the German families, but there were always shortages. Again, resourcefulness eased deprivation. Men made iron bars at the factory to break fishing holes in the ice. Eventually the Germans were paid salaries, with which they could purchase food at neighboring towns.

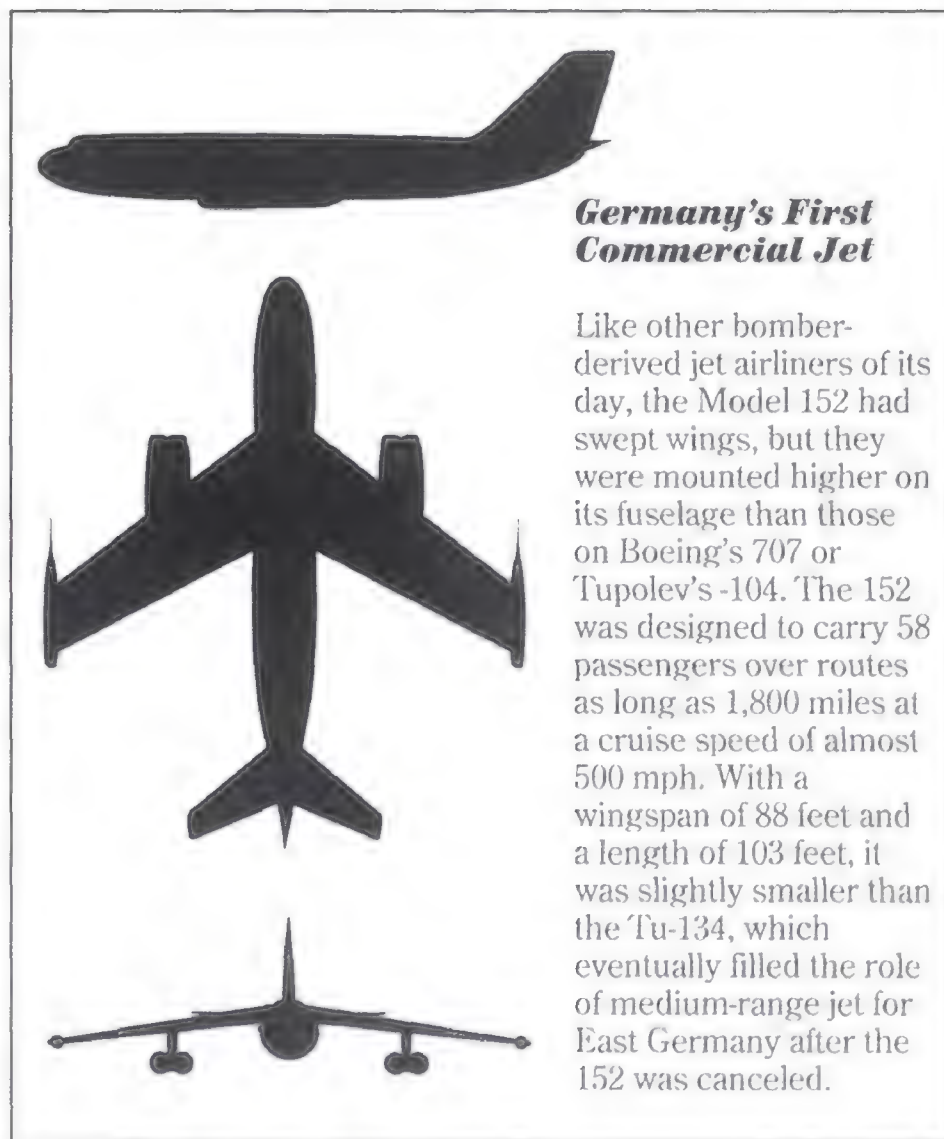
There was no fence to keep them in, but most Germans did not even think about escape. To the north were impassable swamps. To the west was a great artificial lake created by the Volga dam. To the south was the Volga itself with guards patrolling its banks.

Although the Germans were always confined by these boundaries, Podberez'ye became more comfortable for them as the years went by. Photos from the time show boat excursions on the Volga, outings in the forest, and numerous theatrical productions. The Germans could go to larger towns to shop and to Moscow for theater and concerts, although never without a Soviet escort.

Joachim Foellbach was almost 80 when I spoke to him, and when he talked about Podberez'ye, he seemed to focus his eyes on that distant time. "The hard part was the uncertainty," he said. "What was to be our future? Were we going home? When?"

If any of the German expatriates could have influenced the answers to those questions, it was Brunolf Baade. A landing gear designer, though apparently not a very good one, Baade had a gift for leadership. He received rigorous technical training from the Berlin Institute of Technology, which also instilled in him Berlin pragmatism. He was an excellent

The seven-story office building that the East German government built for Brunolf Baade still stands outside Dresden. Baade and his airliner were so important to the country's economy they made the cover of a Life-like magazine in 1958.



Germany's First Commercial Jet

Like other bomber-derived jet airliners of its day, the Model 152 had swept wings, but they were mounted higher on its fuselage than those on Boeing's 707 or Tupolev's -104. The 152 was designed to carry 58 passengers over routes as long as 1,800 miles at a cruise speed of almost 500 mph. With a wingspan of 88 feet and a length of 103 feet, it was slightly smaller than the Tu-134, which eventually filled the role of medium-range jet for East Germany after the 152 was canceled.

speaker and actor, his associates from Junkers recall. "He could charm people," says one engineer.

After the war, the Soviets appointed Baade to rebuild the Junkers factory at Dessau and eventually to act as chief of the German aircraft and engine development effort in the Soviet Union. His relationship with Moscow officials must have been cozy; unlike the other interned Germans, Baade was allowed to travel freely. He and his family were permitted to take unescorted vacations at Crimean resorts on the Black Sea while his countrymen shivered north of Moscow.



With Baade in charge, the Germans continued to develop the swept-wing jet bombers they had been building at the Dessau factory. By 1951 they were testing an aircraft that had a range close to a thousand miles and could carry 13,000 pounds of bombs. With a Soviet designation but a Junkers model number, the two-jet-engine Samolyot ("Aircraft") 150 was a successful design, but it was abandoned in 1952 as the requirements of the Soviet air force shifted to longer-range bombers. Still, the Samolyot 150 had given the German team experience with large (90,000-pound) multi-engine jet aircraft, and Baade saw it as their technology ticket home. As early as 1951, he began to peddle the idea, in both Moscow and Berlin, of building in what was by then East Germany a brand-new commercial aircraft industry around the expertise of his engineers sequestered at Podberez'ye. But although small numbers of Germans and their families had been released by 1951, the Soviets continued to regard German invention as Soviet property.

While the Soviets stalled, Baade lost his moment. Another multi-engine jet bomber entered service in 1951. Boeing's B-47—which began with straight wings until German wind-tunnel data recovered in the war persuaded engineers to sweep them—gave the Seattle manufacturer the experience that would eventually produce one of the most successful



The 152s were essentially hand-built. Whether assembling wings (above) or drilling holes for fasteners (opposite), workers felt a personal commitment to the job, says Erhard Voss (below, holding a piece of a 152 he helped build).

commercial airliners in history, the Boeing 707. And just one year after the B-47 entered service, the Soviets began flying a twin-engine bomber, the Tupolev Tu-16, which quickly evolved until in 1956 it became the first jet airliner to begin sustained, commercial service: the Tu-104. Many years later, some of the Germans wondered if the Soviets' own plans for the Tu-16 had caused Moscow to hold Baade back. But in the early 1950s the dream still seemed possible.

In 1953, after persistent food shortages and worsening economic conditions, workers throughout East Germany revolted over an increase in Soviet-imposed production quotas. Although Soviet forces crushed the insurrection, the revolt finally marked a change in the political relationship between the two countries. When Stalin died that same year, the Soviets stopped treating East Germany as an occupied enemy.

With politicians in Moscow and Berlin now looking for fresh ways to improve the East German economy, Brunolf Baade's sales pitch was beginning to have an effect. At the time he was fond of saying that a kilogram of aircraft-grade aluminum sold for five West German marks on the world market; manufactured into an aircraft, it sold for 200. In December 1953 Baade received permission from Moscow to turn his team's full energies to developing from the Samolyot 150 bomber a large jet airliner, the Model 152. By the time the last Germans left Russia in June 1954, they had the plans and calculations for the 152 and its engines in their



suitcases. The only thing they lacked was the infrastructure to build it.

At a Luftwaffe airfield in Klotzsche on the outskirts of Dresden, Baade set up headquarters for an entire industry. Having been given the highest priority for resources from the East German economy, the repatriated engineers built a seven-story engineering office, test rigs and wind tunnels, and massive construction halls—the largest in Europe at the time—for airframes, jet engines, and electrical and hydraulic equipment.

Baade immediately became a member of the East German Central Committee, even though he had to wait the obligatory three-year period for his Communist Party membership. In this position he was able to influence state planning and make clear that the 500 specialists who had come back from Russia would be too few for the colossal industry he and the German communists envisioned. Orders came from East Berlin for trade schools and institutes to recruit and train production workers, engineers, and technicians.

An airliner industry needs an airline to buy its aircraft. Even before Baade and his engineers got off the train from Moscow, the East German airline Deutsche Lufthansa (later Interflug) was being organized. An airliner industry also needs a national aviation authority to certify airworthiness. East Berlin created one.

The second prototype of the Model 152 flew twice—in August and September 1960. By then the engines designed for it, four Pirna 014 turbines, were ready, but Boeing and Tupolev had already captured the jet airliner market.



The Central Committee opened new facilities and commandeered old ones in Dresden and beyond to support the fledgling industry: a bureau at Pirna, an ancient city just upriver from Dresden, to design aircraft engines and a factory not far south of Berlin to assemble them; factories southwest of Dresden to manufacture precision hydraulics, electrical equipment, and piston engines; plants near Leipzig to make wing flaps, horizontal and vertical stabilizers, and other parts. To design the thousands of smaller components needed, specialists were harnessed into the new industry from all over East Germany: Brandenburg, Halle, Dessau, Rostock, Oranienburg. Eventually 25,000 East Germans would be committed to the project.

Erhard Voss's father was one of the hundreds of workers who moved his family to Dresden to get in on the potential prosperity. At 15, Voss entered an apprentice metal worker program at the factory, and his memories of his work there create a picture of committed, disciplined laborers working to build something they could be proud of. One foreman still has a special place in Voss' memory. The mechanics called him "Rivets" Krause. "He would wipe a ball of cotton over a line of rivets," says Voss. "Any tufts caught on rivets or burrs earned his special attention." (The apprentices probably enjoyed the double meaning of Krause's nickname: The German word for "rivets"—*niete*—is also slang for "loser.")

Voss also remembers exquisitely authoritarian measures to keep tools and small aircraft parts from disappearing into the craft under construction and becoming a hazard later. Each worker was assigned a number; Voss still remembers his: 7240. Every Monday morning he received a dozen met-



al tags marked 7240. He then went to a storeroom where a monitor distributed hand tools in exchange for tags and hung the tags on a board in place of the tool. On Friday the monitor reconciled tools and tags. Any tags still hanging on the board revealed a problem: maybe a tool in an aircraft. The penalty for substituting another tool for one's own was instant dismissal.

The Soviets supported the new industry with technical assistance and, more importantly, orders for and kits to assemble five copies of the Ilyushin Il-14, a short-range, twin-engine airliner, which the Germans continued to produce until 1959. Baade organized his industry into two teams: One team of manufacturing and flight test people honed their airplane production skills with the twin-engine Ilyushin. Chief designer Fritz Freytag took charge of the other team, which polished the designs and put together prototypes of the real prize, the four-jet Model 152.

Baade's Soviet connections continued to serve him well. In the years after 1954, the Soviets sent trainloads of machines and equipment to outfit the East Germans' factories.

Günther Wegener revisits a scene from his past. When he investigated the crash of the 152, he interviewed witnesses who had seen the airplane while they were working on the church's steeple. (Right) Pilot Willi Lehmann, center, and copilot Kurt Bemme, right, were among the four men killed. The entire city mourned. The Dresden Symphony Orchestra played at the service in a factory hall (above). Later, the factory erected a monument to the lost airmen (opposite).



COURTESY GÜNTHER WEGENER

When various shortages held up production, Baade would simply pick up the telephone and call a ministry acquaintance in Moscow. The needed material would be dispatched immediately.

Baade was no less effective with his engineers. Günther Wegener, a flight test engineer for the Model 152, says that Baade could see quickly to the heart of a problem and then get his people working on it. "He was to us a beloved god," says Wegener's wife Ingeborg, Baade's chief of staff for many years. Baade cut an impressive figure:

He was a tall, powerful man with a big head framed by silver hair. His work habits brought him to his office relatively late, about eight or nine o'clock, but he would typically work late into the evening. "It was the Junkers style," recalls Inge Wegener. The Junkers engineers liked the peace and quiet of the evening to think and to work undisturbed.

Despite Baade's inspirational leadership, the dedication of his workforce, and the full support of the communist state, the Model 152 suffered from the two problems that habitually plague aircraft development programs: missed schedules and high costs. Although Baade held weekly staff meetings—Red Meetings, he called them—to assess problems and progress, he became impatient with progress on the 152. He had barely managed the rollout of a prototype to impress Communist Party bosses in April 1958. He knew that he could not buy much more time in Berlin with his charm and socialist vision. "Kiddies," he chided his chiefs, "we have got to fly. Otherwise—no more money from Berlin."

But the teams were working hard already. As they struggled to complete a prototype, the plant was running 24 hours a day, seven days a week. Erhard Voss remembers that for



COURTESY FRANK LEMME



a couple of years, management had lunch delivered to workers at tables in the factory cafeteria to avoid losing precious minutes queuing up for food. Women in traditional black and white waitress uniforms served food selected by the workers from rolling carts. To Voss, these measures instilled the right philosophy in the workers—to value time and strive for quality.

Günther Wegener recalls working every night until nine or ten. They were all emotionally committed to building the 152. According to Wegener and some of the other engineers, the East German people wanted to prove themselves to the world. If they could create an industrial miracle out of the ruins pillaged by the Soviets, they would no longer be perceived as the poor relations of the Westerners.

The strength of the engineers' belief in their abilities was apparent when they returned from Russia. They had the choice to go west or remain in East Germany to help build a new aircraft industry. Twenty left. Hundreds stayed to follow Baade's vision.

Of course by that time, Berlin was also offering premium wages to attract the best workers. All aircraft workers and engineers in Dresden and elsewhere earned a good bit more than their counterparts in other East German industrial sectors. The technicians and builders who had spent time in Russia were paid an additional allowance on top of that.

The people of Dresden also got caught up in the dream. They turned out to cheer the rollout of the prototype on April 30, 1958. And at its first flight almost seven months later, on December 4, even the women who swept the floors in the factories stood by the runway and wept.

They didn't know, of course, and neither did Communist Party secretary Walter Ulbricht, that it flew with Soviet RD-9B engines, used in the MiG-19. Development of an engine for the Model 152 was far behind schedule.

Willi Lehmann, a flight test engineer and fighter pilot who

had been at Podberez'ye with his wife and son, landed the aircraft at Klotzsche without incident 25 minutes after take-off. Lehmann had earned the nickname "Stogram" in Podberez'ye, Russian for "one hundred grams," the capacity of a standard Russian drinking glass. The German engineers hung the nickname on Lehmann when he proved that he could swill vodka with the toughest Soviet drinkers. Lehmann would fly the prototype on its second and last flight the following March.

Early March was always important for the East German communists. It was the time of the big trade fair at Leipzig, a tradition originating in the Middle Ages. After the second world war, the spectacle was used to show off the glories of socialism. The 1959 event was of special significance because Nikita Khrushchev and many other Communist Party and eastern government dignitaries were going to attend.

The political leadership in East Berlin ordered the one flying prototype of the 152 to make a slow, low-level pass over the Leipzig fair. Baade agreed, but he must have known better. Low-level flight is a dangerous regime for a new aircraft design. There is no room to recover from difficulties. Baade must also have known that he lacked the political capital to contest the order and still keep the money flowing from East Berlin.

At 3:00 p.m. on Wednesday, March 4, 1959, Khrushchev and 100,000 spectators waited at Leipzig. The 152 never showed up. The symbol of the East German economic miracle had crashed an hour and nine minutes earlier while rehearsing a low-level pass near Klotzsche.

Günther Wegener's memory of the crash has never faded. "I can remember precisely that morning after breakfast standing with Georg Eismann," he says. "He said to me: 'Boy, Günther, I have the funniest feeling today. I don't know what will happen if I fly today—this funny feeling.'"



COURTESY GUNTHER WEGENER

From a window of the abandoned control tower at Klotzsche, a derelict runway near the aircraft factory is barely visible through weeds. In the early sixties, this same runway was used to test the Model 152 (left, foreground) and Il-14s.

"I said, 'One always has fear with a test flight. But look, if you're really afraid or have a funny feeling, stay on the ground and let Bemme, the copilot, switch on the airborne instrumentation to record the flight parameters we need.'

"But he said, 'Naw. If I fly then we'll make more progress. If I am on board, I can record more things than automatic equipment can.'"

Eismann made his decision in order to help speed the pace

of the program. He and the other four men in the airplane died in the crash. To this day, no one is sure what caused it. There was no telemetry data and no crash-proof black box. An official board of inquiry concluded flaccidly that the accident was caused by an "unfortunate combination of unfavorable circumstances."

The evidence points to a fuel supply problem. Later tests revealed fuel system problems inherent in the design of the 152. The Dresden engineers found inadequate ventilation of the fuel bladders in the wings. In ground tests replicating the nose-down attitude of an aircraft on a glidepath into Klotzsche, the fuel bladders of another prototype 152 were torn apart by pressure differences.

The fuel system had not been tested on a tilt table, as is customary before the first flight of a new model. Later, when engineers ran tilt table tests with clear acrylic fuel lines, they saw air bubbles in the fuel when the shallow glide profile was simulated.

The orders that came from East Berlin after the inquiry were no surprise: information about the crash was to be kept

secret. The wreckage was to be buried; the report was classified. But when factory officials organized the funeral in Building 285, one of the large of the assembly halls, thousands of Dresdeners turned out. The Dresden Symphony Orchestra canceled its tour to China to play at the event.

Fritz Freytag, the chief designer of the 152, led the memorial service. His contemporaries say today that Freytag felt personally responsible for the tragedy. At graveside, however, he repeated the official line about a combination of unfortunate circumstances.

The crash was a watershed event for the East German industry. Some of the engineers left Klotzsche, Foellbach among them. "I knew it wasn't going to come to anything," he said many years later. Wegener recalls that he and his colleagues were at first stunned by the crash, but they quickly recovered. They knew that other jet airliners had had their share of crashes at first.

They knew of the British Comet disasters. A crash was natural. They turned again to the tasks at hand. The Dresden team concentrated on getting a fixed prototype into the air. They designed and installed remedies for the defects in the fuel system, and the next prototype flew without incident on August 26, 1960, more than a year after the crash.

No one saw much of Baade right after the crash. Curiously, he did not show up for the funeral. It was a couple of weeks before he resumed his Red Meetings.

Baade must have known that while crashes of test aircraft are not surprising, this crash could be fatal to his program. Delays putting the 152 into production must have been damaging. By June 1960, Baade had to announce that the delivery of the first 152 would be postponed to 1962.

He knew that East Berlin had dumped more than two billion marks into the industry, a massive subsidy for a small country trying to rebuild its economy. Now it was becoming painfully obvious that there would be no return on the investment. Western jets on the market, such as the Comet, the French Caravelle, and the Boeing 707, were more advanced. Beyond selling a dozen 152s to the state-owned airline, the Germans could not compete. Baade admitted in 1960 that they "would always be limping along behind."

As in the past, East Berlin turned to the Soviets for help, but this time in vain. In October and November, when a delegation to Moscow seeking general support of the flagging East German economy brought up the question of buying 152s from Dresden, the party bosses in Moscow declined. The Soviet Union already had all the capacity it needed for

building airliners. "Then how about building a Soviet jet under license at Klotzsche?" the East Germans asked. The Soviets took it under advisement but never bothered to respond.

In East Berlin on February 28, 1961, the Politburo decided to dissolve the East German aircraft industry. At a Plenum of the East German Central Committee on April 5, 1961, party leaders announced that aircraft construction in East Germany would be terminated immediately. All aircraft, complete or under construction, were to be destroyed. The tens of thousands of aircraft workers and specialists were to be dispersed to other industries.

The factory doors were locked. Inside, men with axes broke up the airframes of the 26 Model 152s under construction. Wegener says the hard aircraft aluminum alloys shattered under the blades. Steel parts were cut up with torches.

Their dream broken, some of the aircraft engineers made their way to East Berlin and to the West through the last gap in the Iron Curtain. Fritz Freytag, Baade's chief designer, was among them. Four months later, Erich Honnecker walled off East Berlin. The files on the 152 were locked and sent to Moscow.

The central committee's action left an industrial vestige, the Dresden Aircraft Depot, which continued to operate for three decades, mainly to repair, overhaul and re-

assemble Soviet-built MiGs and helicopters. In 1991, the year after Germany reunified, Deutsche Aerospace purchased the depot, and today machinists are again working on big airliners in the great aircraft assembly halls at Dresden. Their new assignments include outfitting Airbus fuselages, building aft fuselage sections for Fokker 70s and 100s, and overhauling Boeing 737s.

In the midst of this work, the Dresdeners also completed a task that reflects the newer political turnabouts in their part of the world. As signatories to the 1990 conventional-arms reduction treaty between NATO and the countries of the Warsaw Pact, both West and East Germany were required to destroy fighter aircraft. When the time came to dispose of the airplanes, however, the Warsaw Pact had dissolved, the two Germanys had united, and one government owned both sets of fighters. Rather than try to refit the older aircraft from the East to fly in the West, the Germans decided to destroy them anyway. And in 1993—in what seemed like an eerie re-staging of the destruction of the Model 152s—the Dresden workers broke apart 140 MiG-21s that the machinists had serviced as East German citizens. —



When the 152s were broken up for scrap, the East German air force took two fuselages to use for storage. One survives, having spent years in this field at a former fighter base near Poland.

SEEING STARS

The atmosphere is a wonderful
thing, but astronomers find it a
nuisance. Now they're developing
a method to overcome the
blurring effects of turbulent air.

by Tony Reichhardt

Photographs by Roger Ressmeyer—© Corbis

Humming cheerfully as he works, Chris Shelton bustles around the base of the 100-inch reflector at California's Mt. Wilson Observatory, his footsteps echoing inside the vast metal dome. He grabs a wrench half the size of a baseball bat and scrambles onto the open cage-like structure that supports the giant telescope. "Now to get this tertiary mirror aligned," he says, disappearing inside the cage. "Soon it'll be dark enough to start observing."

This is the way astronomical observatories are supposed to look but rarely do anymore: The dome has heavy, riveted walls, with thick cables and pulleys that open its slotted roof. The telescope controls are dark wood and brass, relics of an era pre-dating high-resolution computer displays and fiber optics.

It was on this platform in the 1920s, sitting in a straight wooden chair with his eye to a cold eyepiece, that Edwin

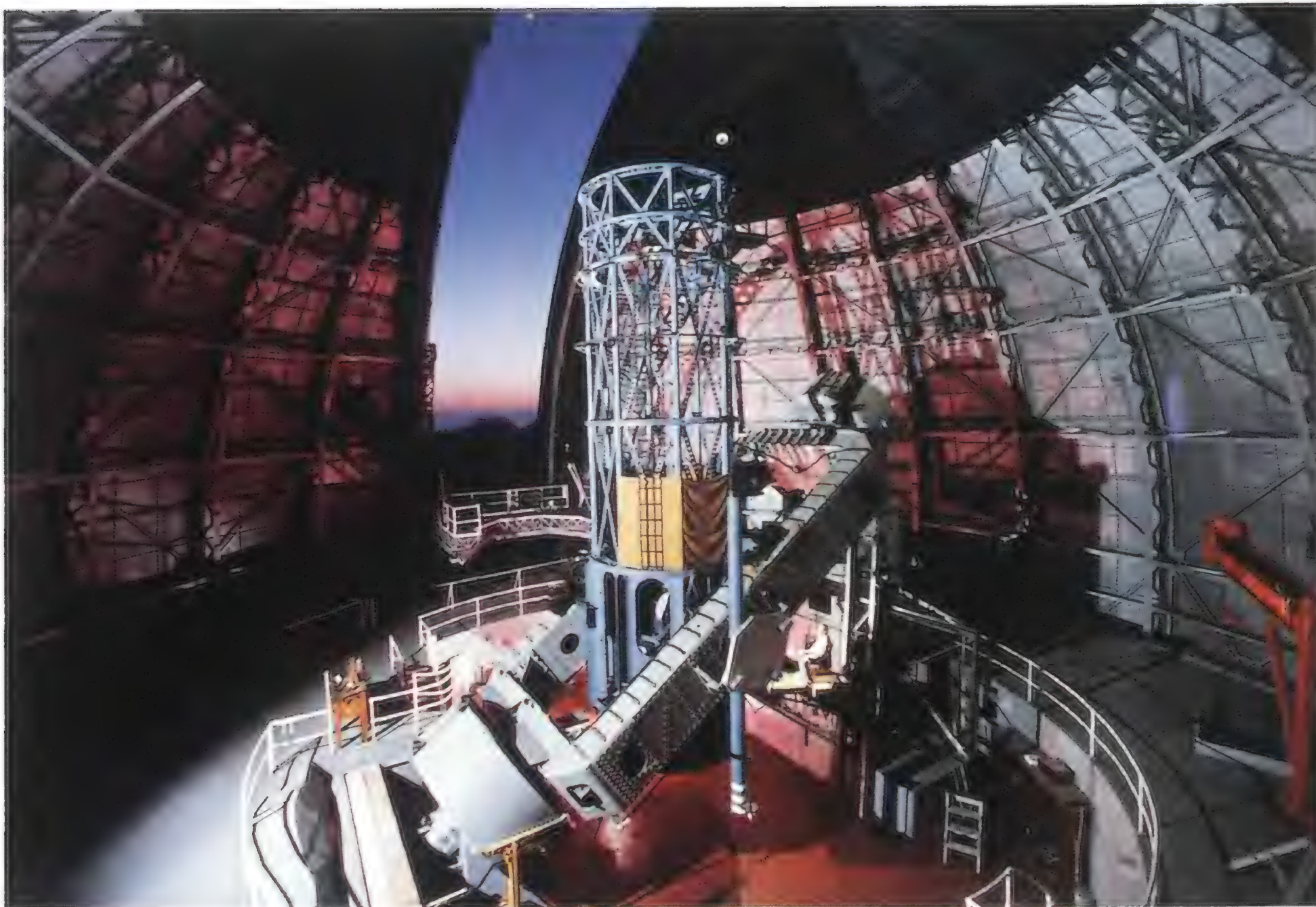
Hubble enlarged our concept of nature by observing objects he determined were galaxies beyond our own Milky Way. Until the 200-inch at nearby Mt. Palomar usurped it in 1949, this 100-inch Hooker telescope, named after the Los Angeles businessman who funded it, was the largest and most powerful in the world. By the 1980s the bright lights of Los Angeles had ruined Mt. Wilson's sky for faint observations, and the 100-inch was mothballed—more for financial reasons than for any flaw in the instrument. But now the Hooker is coming back to life. Two separate teams, one led by Shelton and the other by Laird Thompson of the University of Illinois, are fitting Edwin Hubble's telescope with "adaptive optics"—technology that dramatically sharpens astronomical images by counteracting the blurring effects of the atmosphere with high-speed computers and a "rubber" mirror.

For the past couple of years Shelton has been upgrading the old telescope, making it better than Hubble could have imagined, better in some ways even than the multibillion-dollar orbiting instrument that bears his name. While the Hubble Space Telescope can resolve details as small as 0.1 arc-second, the upgraded Hooker has already beaten that resolution—although for only very limited fields of view.

Virtually unheard of ten years ago, adaptive optics, or AO, is a technology astronomers now plan to install on practically every large telescope in the world. Only a handful of observatories have used the technique for astronomy—among them the European Southern

A laser at the Starfire Optical Range's 1.5-meter telescope creates an artificial guide star in the night sky.





Chris Shelton (left) is overseeing the installation of an adaptive optics system for Mt. Wilson's 100-inch telescope (above). Edwin Hubble used this instrument to observe objects he determined were other galaxies.

Observatory in Chile, Mt. Wilson, and the Air Force's Starfire Optical Range in New Mexico, one of the incubators of AO technology. Many bugs still need to be worked out, and the ultimate performance of AO is yet to be determined. But no one doubts that it's the wave of the future. According to a 1991 report from the National Research Council, "The scientific gains from applying adaptive optics will have an enormous impact on many branches of astronomy."

If the 1980s was the decade of space-based astronomy, the 1990s is shaping up to be the decade astronomy came back to Earth. New technology and advanced lightweight mirrors have led to

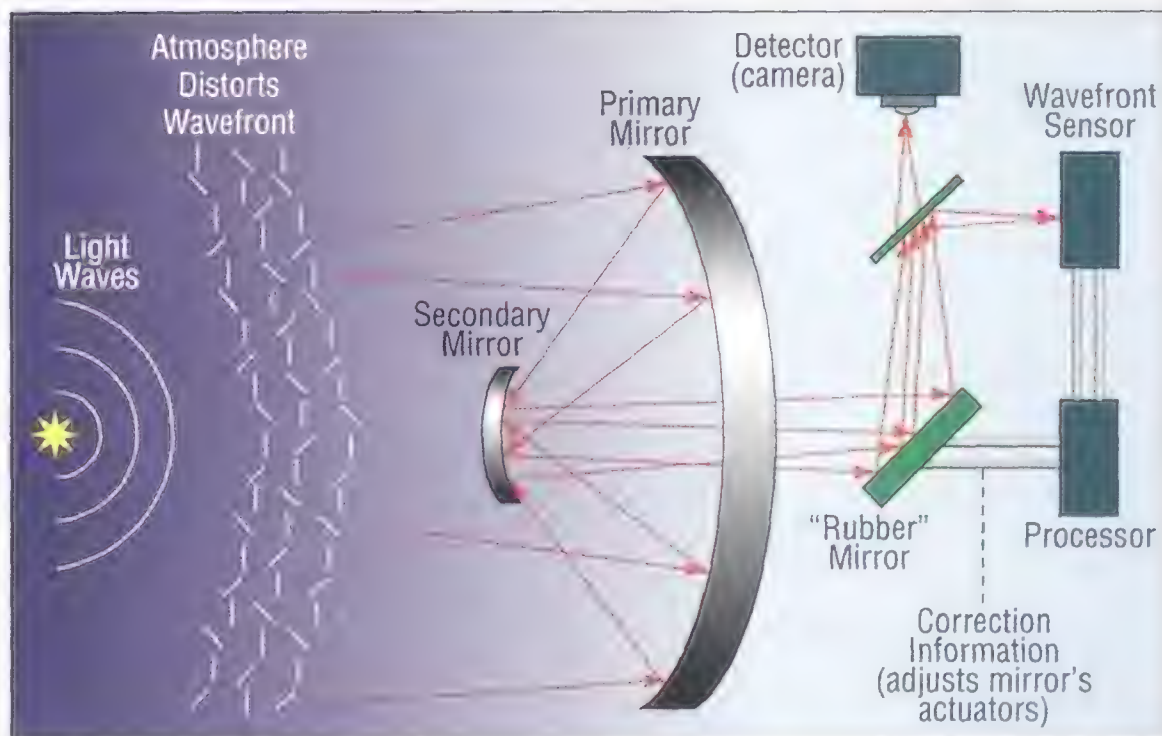
an explosion of plans for large ground-based instruments—six, eight, ten meters in diameter—all scheduled to come on line in the next five years. The bigger the mirror, the more light a telescope gathers and the fainter the objects it can see. But no matter how large a telescope is, its ability to see fine detail—its resolution—is limited by the atmospheric turbulence overhead, which smears crisp starlight into messy, flickering blobs. Whether using the 10-meter Keck Telescope in Hawaii or a 12-inch backyard model, observers on the ground are doomed to view the universe through an ever-moving river of air.

Astronomers have devised some fairly exotic ways to try to beat the problem. Speckle interferometry, pioneered in the 1970s, involves taking extremely short exposures of an astronomical object—snapshots showing how the atmosphere distorted the image at those particular instants—then using a computer to infer from these distorted views what the unblurred image would look like. The technique, although useful, remains something of a black art, and has a slight taint of artificiality.

A far better solution is to put telescopes in space, above all the turbulence. But that is still an enormously expensive undertaking. The Hubble Space Telescope (at 2.4 meters, about the same size as the Hooker reflector on Mt. Wilson) costs many times what the two 10-meter Keck Telescopes in Hawaii will cost. The HST is unmatched in many ways, but no one is rushing to launch another one.

Adaptive optics is a different way to solve the problem. By measuring the rapidly changing atmospheric distortion at very short time intervals, then introducing an equal but opposite distortion with a mirror that can just as rapidly change its shape, astronomers can compensate for atmospheric turbulence. The principle is similar to NASA's use of prescription optics to correct the Hubble Space Telescope's blurred vision. The difference is that in AO, the "prescription" might change every thousandth of a second (see "How AO Works," right).

The general concept was first proposed in the scientific literature by astronomer Horace Babcock in 1953. A handful of scientists and military re-



How AO Works

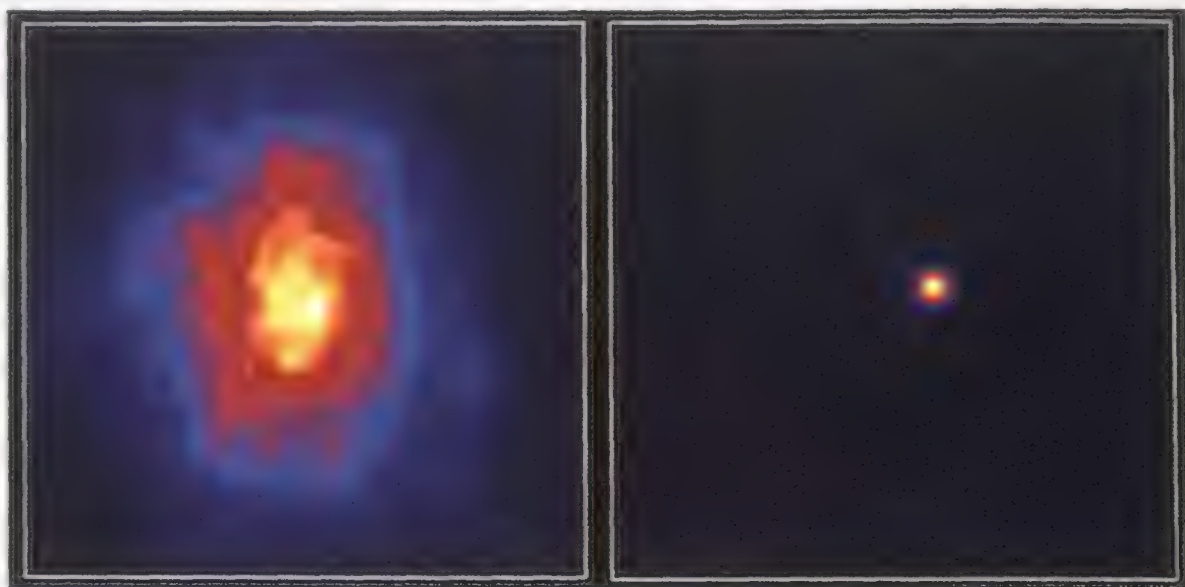
If the air above us flowed in a smooth, predictable stream, astronomers wouldn't have a "seeing" problem. But the atmosphere, it turns out, is rather lumpy. It's made of parcels of air, some warmer, some cooler, all with different densities and refractive characteristics. This patchwork of air cells moves continuously, changing the seeing from millisecond to millisecond. The idea behind adaptive optics is to measure how these air cells bend the incoming light, then to use a deformable mirror to cancel out the distortion—all in real time.

Sounds easy, but getting it all to work together is the hard part. The process starts with a wavefront sensor. Light from a star or galaxy travels through billions of miles of empty space as an even, unbroken wavefront, like an ocean wave approaching a beach. But when it meets the roiling atmosphere, the line is broken into pieces, known as subapertures, each of which bends differently depending on the air cell it encounters. The more turbulent the atmosphere, the smaller

the subapertures. Most AO wavefront sensors measure the individual tilts of those bent pieces. A computer then "straightens" out the tilts to reconstruct what the original wavefront looked like.

That information is then fed to electrically driven actuators on the back of a deformable "rubber" mirror in the telescope. The computer commands the actuators—which can number anywhere from a dozen or so to many hundreds—to change the shape of that part of the mirror to compensate for the distortion of that air cell. The "re-straightened" wavefront is then passed on to the telescope.

Adaptive optics does have its drawbacks. Because compensating for the complexities of large sections of the atmosphere is difficult, AO telescopes look at only tiny portions of the sky; providing a corrected view of Jupiter's full disk, for instance, is beyond the capability of current systems. It's also more difficult to correct for shorter wavelengths, so AO systems are best used for the longer wavelengths of the infrared rather than the shorter ones of visible light.



At left is a star as seen by the Starfire Optical Range without use of adaptive optics; at right adaptive optics has reduced the atmosphere's blurring effect. The small ring around the star is a diffraction pattern known as an Airy disk.



searchers tinkered with the problem for the next 20 years (the military wanted to photograph enemy satellites from the ground), but it wasn't until the late 1970s that all the necessary technologies started coming together. These included sensors capable of measuring precisely how the smooth, steady "wavefront" of light from an astronomical source was bent (refracted) by air cells, computers fast enough to do the real-time calculations, shape-shifting mirrors, and a better understanding of atmospheric dynamics.

In 1983 a team led by Robert Q. Fugate at the Starfire Optical Range, part of the U.S. Air Force's Phillips Laboratory in New Mexico, added an important new tool to the arsenal—laser "guide stars." AO wavefront sensors generally require lots of light, which means the

technique works only if a relatively bright star is within the telescope's field of view. But bright stars are few and far between, leaving big holes in the sky where conventional AO is of no help.

The Starfire team solved the problem by bouncing a laser beam off a high-altitude layer of the atmosphere, then using the reflected laser light to char-

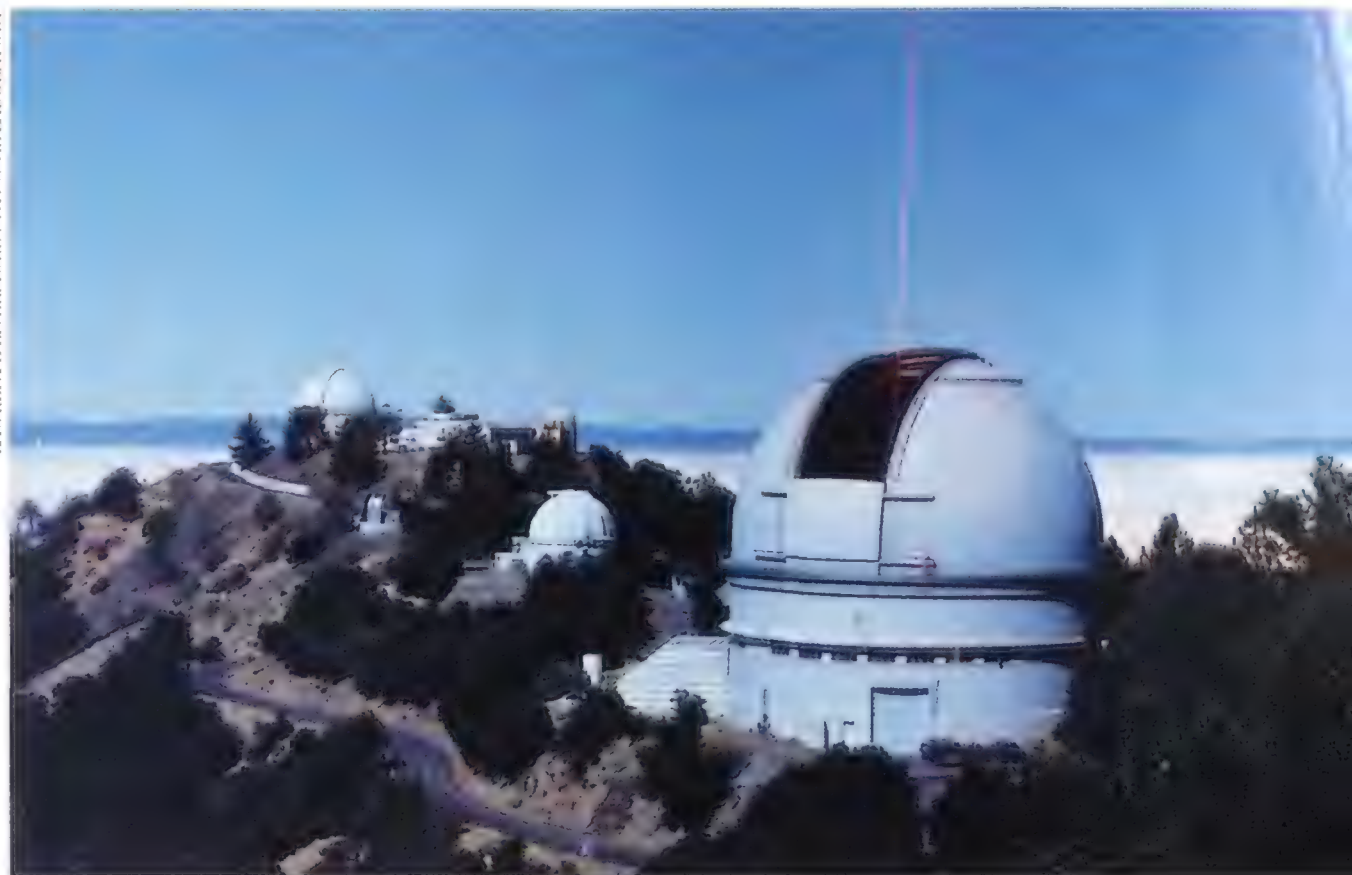
acterize the distortion. In principle, lasers could open up the whole sky to AO-corrected viewing, since you can point the artificial beacon anywhere.

For the rest of the 1980s Fugate and his team worked long hours fine-tuning the technique. Since parts of the research fell under the umbrella of classified military programs, the team members couldn't discuss it with civilian astronomers. For a collegial person like Fugate, that was a form of torture. In 1991 the Pentagon finally let him discuss his AO results in public, and ever since he's been giving free advice to just about every group working on AO systems for astronomy.

Claire Max of the Lawrence Livermore National Laboratory in California calls Fugate "a proselytizer." Like Fugate, Max toiled away on secret military AO projects in the 1980s, unable to discuss them with her colleagues in the civilian world. When the secrecy finally lifted in the early 1990s, she says, "Bob Fugate and I were the two people who pushed hardest on the inside to get this stuff opened up to astronomers."

Today, only Fugate has a fully operational laser-based AO system. But his is designed more for satellite-spotting than for science, which leaves several teams vying to produce the first laser-based system specifically for astronomy. A group Max heads is testing a system on the three-meter telescope at California's Lick Observatory, while Laird Thompson is working on Mt. Wilson. Another team, led by Edward Kibblewhite at the

LAWRENCE LIVERMORE NATIONAL LABORATORY



Once prevented by secrecy laws from discussing his adaptive optics work, Robert Fugate (above) can now spread the AO gospel. The system at Lick Observatory (right) also started as a secret military program.

University of Chicago, is building a system for a similar-size telescope at Apache Point, New Mexico.

The teams take different technical approaches to such details as laser design. Each has its potential pitfalls, and

each team is convinced that its way is the best. "This is a very competitive business," says Fugate, "and everyone's out there on the edge, hanging by a thread." No one has worked out all the kinks, although last fall Max's team produced the first atmospheric "corrections" using a sodium laser (which places its beacon at a higher altitude than other lasers and so enables corrections for more of the atmosphere).

Most of the teams have benefited in one way or another from military largesse. Kibblewhite, for example, inherited an entire Pentagon-developed adaptive telescope that was supposed to have flown on the space shuttle but got bumped when the Star Wars effort was scaled back.

While grateful for the help and mindful of the pioneering role military scientists played in advancing the state of the art, most civilian astronomers working on AO will tell you that by the time the Pentagon decided

to go public in 1991, the ideas behind adaptive optics were no longer revolutionary. Roger Angel of the University of Arizona's Center for Adaptive Optics says, "My own cynical view is that astronomy was so far along in getting to all this stuff anyway that there wasn't a lot [of secret information] to protect."

Indeed, it was civilian scientific advisors who first suggested to the military the idea of using laser guide stars. And in 1985, two French astronomers, Renaud Foy and Antoine Labeyrie, published a paper on laser guide stars for AO, years before the Pentagon disclosed its own experiments in the field. With or without the Department of Defense, says Angel, astronomers are "plenty smart enough to have figured it out themselves."

Just as there is competition among the different teams working on laser-based systems, another rivalry exists between laser devotees—mostly Americans with some links to the U.S. military—and those astronomers, mostly non-Americans, who prefer working with lower-tech systems and natural guide stars.

One of the leaders in the "natural" camp is François Roddier of the University of Hawaii, who has been using a non-laser AO system at the Canada-France-Hawaii Telescope (CFHT) on Mauna Kea for a couple of years, quietly and effectively producing real astronomical results while most laser-based systems are still in the experimental stage. Roddier says that rather than jump on the laser bandwagon, which adds complexity and cost, "My philosophy is 'Let's do as much as we can with natural guide stars.'" His approach is technically different from most U.S. systems, and in many ways simpler. His deformable mirror, for example, has only 13 "correction elements," or segments that can be shaped independently. Some laser-based systems have hundreds.

When he first went looking for support from the National Science Foundation in 1988, Roddier felt snubbed by an establishment he says was wedded to the military way of doing things. The Pentagon, he charges, was seeking a way to peddle leftover Star Wars technology—including lasers—to the scientific community, saying to themselves,



Roger Angel, surrounded by glass that will be spun into a mirror for the Multiple Mirror Telescope, hopes his new telescope will see planets around other stars. François Roddier (with wife Claude, below) has a system that uses natural guide stars, not lasers.



"Maybe we can convince astronomers they need this."

That left Roddier to scrounge parts on his own and build a system on the cheap. But with the help of Mauna Kea's naturally good seeing, he has been able to achieve corrected images using guide stars as faint as 16th magnitude (slight-

ly dimmer than the planet Pluto). That still doesn't give full-sky coverage, but Roddier says laser systems have yet to demonstrate that they can reach that goal either.

Even the laser AO camp concedes that his scientific results have been impressive, and the NSF now funds Rod-

dier's alternative work. But the argument over which approach makes more technical and economic sense continues. Ultimately, says Chris Shelton, "it's a lifestyle issue"—astronomy's version of the culture clash between power boaters and sailors.

Laser AO systems do face a number of hurdles, not all of them technical. At both the Starfire and Lick observatories, whenever the laser beam is on spotters have to stand on the roof and watch for overflying airplanes. (There is also a safety officer who watches for aircraft on a radar display forwarded by an air traffic control center.) If one comes within a certain range, the spotter calls down to the control room and the laser is shut down. Max thinks this eventually won't be an issue, particularly if infrared cameras can do the airplane spotting automatically. But until then, it's one more thing to worry about.

Laser systems also require large crews, at least at this experimental stage. Starfire, for example, uses up to seven people when the laser is running. "In astronomy you can't afford that," says Shelton. Most observatories typically have a single person running the telescope for a visiting astronomer. One of Shelton's main goals at Mt. Wilson, in fact, has been to design the system so it can be operated solo.

Laser systems pose a potential problem when several telescopes share the same mountaintop. "Nobody wants to shine a laser up in the air if it will ruin everybody else's observing," says Max. "On a crowded summit like Mauna Kea, it's a concern." In fact, as more laser-based AO systems begin operating this may become a hot political issue for astronomy. Right now, several observatories with plans for large telescopes are carefully watching Max and the other pioneers before committing to a laser system. Max is helping design the adaptive optics for one of the twin Keck telescopes, but the instrument's planners have not yet decided whether to use lasers. Other planned observatories, like the Very Large Telescope, a cluster of four giant (eight-meter) instruments being built by the European Southern Observatory in Chile, are also reserving judgment until the technology is further along.

This wait-and-see attitude should



Night on SOR Mountain

"Beam's up."

A group of women, having just cleaned up after a reception for visiting Air Force brass, stop momentarily to admire the spectacle as they step out into the cool New Mexico night. The thin green laser beacon emanating from the observatory picks delicately from one star to another, like a pointer at a planetarium. The women have seen it all before, though, and without another word they pile into a car.

Just another night at the Starfire Optical Range.

Inside the dome, master of ceremonies Robert Q. Fugate is awaiting his next guests—two NASA astronomers who want to use the AO system to get sharp images of Saturn's moon Titan. Fugate, who helped pioneer laser-based AO more than 10 years ago, has also struck a deal with the National Science Foundation, which is funding some two dozen nights for astronomers to come to the SOR to get hands-on experience with the new technology. The visits don't account for much of Fugate's time—95 percent of Starfire's work is for the military—but he likes helping out the

astronomical community.

"Closing the loop," calls one of the technicians, meaning that the AO system has just been turned on. Suddenly, the dancing fireflies on the TV monitor collapse into a tight circle. What was unrecognizable a second ago now appears clearly as the image of a bright star. It's a dramatic and instantaneous improvement.

Tonight may be a bust, though, AO or no AO. For one thing, there's a 20-mph wind buffeting the telescope and making it hard to hold a steady image. "This thing is bouncing all around here," says Fugate, peering at the image on the monitor. And cloud cover threatens to cancel the Titan observation anyway. There's nothing anyone can do about the weather, even with millions of dollars of Pentagon technology.

At least the Air Force visit went well. In fact, at the exact moment the SOR technicians had turned on their laser for a demonstration, a bright meteor had streaked across the sky, wowing the general and his staff. Visitors usually come away impressed with Starfire, jokes Fugate, who clearly likes showing off his baby. "But now they'll expect a meteor every time."



The 3.5-meter telescope at the European Southern Observatory in Chile points a "rubber" eye at the sky.

come as no surprise—after all, the number of astronomers who have direct experience with AO is still fairly small. "Until you actually do it," says Shelton, "everyone just goes 'Right, sure.' The talk-to-do ratio in adaptive optics is still pretty high."

But so are expectations. High enough, in fact, that AO aficionados dare to make comparisons with the Hubble Space Telescope. Is the advent of AO, coupled with large ground-based instruments, already turning NASA's pride and joy into a dinosaur?

Hardly, says Roger Angel, who predicts that the HST will have "a long-lasting niche in visible imaging." For one thing, it delivers sharp images across its entire field of view (28 arc-minutes in diameter), unlike AO, which corrects only one tiny spot at a time (to about 20 arc-seconds, or up to one arc-minute in the infrared). The HST is never bothered by weather or airglow. It sees in the visible-light and ultraviolet wavelengths, whereas AO gets its best results in the longer infrared region. (The shorter the wavelength, the trickier it is to correct for atmospheric distortion.) Matching Hubble resolution in the visible wavelengths with a ground-based AO system would require numerous high-powered lasers, faster computers—better everything.

Not worth it, says Angel. "As an instrumentalist I wouldn't get the slight-

est pleasure out of busting my guts on an enormous, complex system only to equal what we've already got."

The infrared is a different story. Shuttle astronauts will install a new infrared camera on the HST next year, but astronomers expect it eventually to be outperformed by AO-equipped instruments on the ground.

Another advantage AO systems have over space telescopes is that they're available to many more people. "The [HST] is a terrific instrument," says Fugate, "but there's only one of them." For what the space telescope cost, practically every observatory in the world could get an AO system like Chris Shelton's, which he estimates could be duplicated for a measly half a million dollars. In fact, part of the reason the NSF is funding so many AO projects is to drive down the cost and complexity of adaptive optics, and to get the technology into the hands of more astronomers.

At the other end of the complexity scale, the Air Force Office of Scientific Research is providing funding to Angel's Center for Adaptive Optics for the next big advance in the field—a secondary mirror that would itself be de-

formable, which would greatly increase the sensitivity of the entire system by eliminating the need for further optical corrections before the science imager. Angel, one of the premier telescope builders in the world, plans to build this technology into the AO-adapted 6.5-meter Multiple Mirror Telescope (MMT). Jointly run by the University of Arizona and the Smithsonian Institution, the telescope is set to open in Arizona next year.

Many astronomers think that if anyone can pull it off, Angel can. "Roger's my kind of guy: Damn the torpedoes and full speed ahead," says Fugate. "He's definitely into risk-taking." In fact, what Angel really wants to do is to set the AO-controlled MMT looking for planets around other stars. This could, in fact, be the ultimate coup for AO systems—the first direct images of Jupiter-size worlds beyond our own solar system, a prize beyond the reach of the current HST.

That's still in the future, though. Meanwhile, the pioneers keep tinkering. What's the hardest part of developing adaptive optics? To a person, AO researchers answer: "Getting the whole system to work together."

And when will that job be finished? Wrench in hand, Chris Shelton answers, "I don't think you ever get 'finished' with these systems. It's still a little early to be finished." —





So You Want to Set a Record...

Do you have what it takes? Our writer thought he did.

by Phil Scott

Illustrations by David Peters

Thursday, June 15, 1995, 12:19 p.m.: The tower clears me for takeoff. My tiny red and white Cessna monoplane, The Spirit of Farmingdale, bounces down the runway slowly at first, its wings heavy with fuel. I hold it on the ground until the airspeed gauge shows 60 knots, then pull back on the yoke. We're airborne.

"Mark: sixteen-twenty-oh-one Zulu," says the tower. Zulu—that's Greenwich Mean Time, five hours ahead of Eastern Standard. I gradually turn the airplane due north and let it climb to 1,500 feet before I level off. No use wasting time by climbing higher. I have a record to set.

My journey into the record books actually began months before, on a gloomy New York winter's morning. Looking out my dirty window at dirtier gray skyscrapers, I felt more acutely than usual the intimations of mortality in most of my major joints. I had been working on a book about the early days of flight, and the night before I'd been looking up record flights in an old almanac. As I straightened up my desk, I reached for the almanac and a headline jumped out at me: "Five Easy Steps to Set an Aviation Record."

It was exactly the jolt of inspiration I needed.

Airspeed: 100 knots. Fuel: full on both tanks. Over Long Island Sound now, I steer The Spirit of Farmingdale's nose east, toward our distant goal. The engine seems to start running rough, but I know that's just a trick your mind plays on you when you're over vast stretches of water. I see little boats bobbing in a harbor below, unaware of my daring adventure unfolding above them.

The first step listed in my almanac was to contact the National Aeronautic Association. The NAA is the organization responsible for keeping aviation records for the United States, as well as the nation's representative in the Fédération Aéronautique Internationale, the world's record-keeper, based in France. Both have been around since 1905; until the 1920s the NAA was the body that issued pilot's licenses in the United States.

I called the NAA and poured out my hopes of having my name added to the pantheon that included Lindbergh's, Earhart's, and Yeager's. Not long after, I received my official Record Attempt Kit in the mail. The kit contained lots of procedural instructions, certification forms, applications for the required NAA sanction and FAI sporting license, and even an offer for an NAA Visa card. My confidence rose; pioneering aviators like Louis Blériot and Glenn Curtiss never enjoyed such advantages in their ground-breaking flights.

The NAA also sent along its latest of-

ficial record book, with 400-plus densely typeset pages listing every current record the organization recognizes. In the last 90-odd years, mankind has pushed the Absolute Records—farthest, fastest, and highest in the world,

regardless of aircraft class—from just a few feet and a few miles per hour to extraordinary figures: 123,523 feet

for altitude (Alexander Fedotov flying a MiG-25 in 1977), 2,193 mph for speed over a straight course (Eldon Joersz, SR-71, 1976). Below the Absolutes

are world and national records categorized by type of craft, weight, and powerplant.

Then there are those in the oddball "Special Categories,"

which are recognized by the NAA but not the FAI (see "Off the Beaten Path," below).

But what about someone who just piddles around in a two-seat Cessna on weekends? Is there any room in the record book for him?

As it turns out, all you really need to do to get in is fly from one city to another. If your destination is at least 200 kilometers (125 miles) away, you can set a national "Speed Over a Recognized Course" record; if you're feeling even more ambitious, set a goal 400 kilometers away (or in another country) and your flight can qualify you for a world record. When you consider all the combinations of city pairs, multiply them by the variety of aircraft (balloons, hang gliders, sailplanes, fixed-wing, rotary, etc.), times the types of engines

(piston, turboprop, jet, rocket, human muscle), then factor in an alphabet's worth of weight classes, well, that equals a lot of potential records to set and break.

But fame costs. The NAA charges one fee for a sanction to make an attempt and another for registering any record set (the fees account for about 20 percent of the NAA's operating revenues). Total costs run anywhere from \$275 for a commercial aircraft on a scheduled flight to \$3,500 for an Absolute World Record. Occasionally the NAA has a sale: Last year pilots wanting to set records flying to the Experimental Aircraft Association's annual fly-in at Oskosh, Wisconsin, were charged just \$299. The attempt I decide to make—setting a national record by flying a Cessna 152 from Farmingdale, Long Island, to Martha's Vineyard, Massachusetts—will cost a total of \$750.

In return, each year the NAA holds two ceremonies (one at the National Air and Space Museum) to present the most recent crops of record setters with nice plaques—just the thing to cheer them up on gloomy winter days.

Airspeed: 100 knots. Fuel: left tank, full; right tank, three-quarters. The air feels much smoother now that I'm flying over the Sound. Below me, long sandy beaches slip by. For a moment I wish I could be down there swimming. But I still have much work to do. Through the haze I can make out the northeast tip of Long Island. My little airplane and I forge ahead.

The NAA is located in a nondescript office building in Arlington, Virginia, just outside Washington, D.C. The man to see there about setting a record is Arthur Greenfield, who each year certifies between 150 and 200 records. Most are of the city-to-city variety. Setting these records seems to be primarily an Amer-

Off the Beaten Path

From the 1995 *World and United States Aviation and Space Records and Annual Report*, National Records Special Categories:

Duration in a Hang Glider (Solo):

34 hrs., 3 min.
James W. Will
UP Gemini 165
Makapuu Point, Hawaii
June 3–4, 1986

Fastest Time To Visit All the State Capitals in the Contiguous U.S. and the District of Columbia:

13 days, 7 hrs., 42 min., 25 sec.
Dr. Hypolite T. Landry, pilot
Clifford H. Rice, copilot
Cessna R-172K
Aug. 6–19, 1990

First Family to Fly Over the North Magnetic Pole in a Single-Engine Aircraft:

Olin, Paula, and Jack
Branstetter
Piper Cherokee 180, N7746W
June 29, 1984

ican mania. Maybe that's why, of all 93 national members of the FAI, only the NAA bothers to publish an annual record book.

Greenfield checks his computer and confirms that the airports I'll be using are the requisite 200 kilometers apart (on a great circle course—the shortest distance over the surface of the earth between two points) and that no one has ever registered a flight between the two as a record. If I succeed I'll not only hold a record, I'll have an all-important "first" as well.

Greenfield tells me to contact the control tower personnel on both ends of my course (Step 4)—they'll be verifying my takeoff and arrival times. He explains that in most cases, when a flight originates within 60 kilometers of a major city, the NAA classifies it as starting from that city (though it calculates speed from the actual distance flown). Therefore, my official documentation will read "New York to Martha's Vineyard."

Now it almost sounds impressive.

Airspeed: 100 knots. Engine instruments: within normal range. A line of angry-looking dark clouds floats low along the north, blocking my view of the New England coast. I can't yet make out my next major landmark, Block Island, through the haze, though I know it's 20 miles ahead. I'm too low for my navigation radio to pick up the beacon on Martha's Vineyard. If it keeps up like this I may be forced to turn back.

Why do we want to set records anyway? Well, a record can get you noticed. Back in 1957 a hard-charging Marine fighter pilot named John Herschel Glenn Jr. took it upon himself to fly a supersonic F8U Crusader to a new coast-to-coast speed record: three hours, 23 minutes,



50 seconds. In addition to getting him a contestant's slot on "Name That Tune," the accomplishment helped catch the attention of an audacious man-in-space project looking for pilots with, um, that certain something. In 1962 Glenn became the first American to orbit Earth (and shatter a national space endurance record in the process). Afterward, he made a lot of business contacts and a fortune to boot, and later won a seat in the U.S. Senate.

Records can help you make a point. Back in 1949, the Boeing B-50 *Lucky Lady II* flew around the world nonstop in 94 hours and one minute. Not eight years later a flight of three Boeing B-52s chopped the record in half, to 45 hours and 20 minutes. Beneath the surface, such flights sent a clear message to the Soviet Union: Every inch of its landmass was within striking distance of our nuclear bombers. Of course, there were two lanes on that superpower superhighway. Only three months after Alan Shepard's 1961 suborbital lob in his Mercury capsule, the Soviets lofted Gherman Titov for 17 orbits, smashing the one-orbit endurance record set less than four months before by their man Yuri Gagarin. The disguised message here: The Soviets had the missile power and the technology to loft a nuclear warhead at any target on the planet. And so a history of the arms race can be written through the records that the superpowers chose to set.

But record books don't always give the whole story. The first powered flight was 120 feet, made by Orville Wright on December 17, 1903, right? Well, back then there was no FAI and thus no trained FAI observers—just a bunch of guys helping out from the Kitty Hawk lifesaving station. As far as the FAI is concerned, the first confirmed, sustained flight was 197 feet, made by Alberto Santos-Dumont in *14-bis* on October 23, 1906. The Wrights also get no official credit for being first to fly a circuit of one kilometer or more. Again: no official FAI-approved observers. That honor went to Henri Farman, flying a Voisin biplane in 1908—more than two years after the Wrights had accomplished the same thing.

And not all records are records. Just ask 13-year-old Victoria Van Meter of Meadville, Pennsylvania, who at age 11 became the youngest female to fly across the country, the youngest female to fly from the east coast to the west, and the youngest female to fly the farthest distance. At age 12 she also became the youngest female to fly across the Atlantic. (She made all the flights with instructors.) None of these records are official, however. Despite its plethora of categories and sub-categories, the NAA record book has no age divisions. The rules clearly state, however, that you must hold at least a recreational pilot certificate, and for that you must be at least 17. But it doesn't really matter to Van Meter. "The point of doing the flights was a self thing," she says. "I did them for myself, as a challenge to my-

First Person to Circumnavigate the Island of North Dumpling:

Richard Rutan
Enstrom, N36DK
1 min., 34 sec.
June 29, 1988

Number of Consecutive Inside Loops:

2,368
David Childs
Bellanca Decathlon
North Pole, Alaska
Aug. 9, 1986

Number of Different Aircraft Flown in One Day:

65
Col. Tom A. Thomas Jr.
Frederick, Oklahoma
June 1, 1985

Fastest Time to Visit All 128 Hard-Surface Public Airports in Michigan:

1 day, 12 hrs., 5 min., 3 sec.
Patrick J. and Juanita D. Curley
Piper PA-28-181
June 30, 1993





self." Nor does the young pilot have plans to pursue any records officially. "Records aren't important to me," she claims. "When I get my license I'm just going to have fun with it being a private pilot."

Airspeed: 100 knots. Fuel: three-quarters left tank, three-quarters right tank. Engine instruments within normal range. I'm out over the Atlantic now. There's a light rain splattering my windshield, but up ahead the clouds seem lighter and Block Island grows larger. I can make out a dark line on the horizon. It's either heavy clouds or land. As I press on, I fantasize about nicknames an adoring press might bestow upon me—"Lucky Philly" perhaps, or "The Lone Beagle." How will the public remember me?

The harsh truth is: probably not at all. Back before World War II the exploits of Jimmy Doolittle (coast to coast in 21 hours), Amelia Earhart (coast to coast in 19 hours), and Wiley Post (around the world in eight days, 15 hours) won the public's admiration. They were the first, the fastest, the farthest. And they all had a message, whether it was aviation's safety, reliability, and potential, or women's ability to do things just as well as men.

But today, a quarter-century after men traveled to the moon and back, people find it hard to get worked up about much of anything record-wise. Last year Norm Thagard spent 115 days in space aboard the Russian space station Mir, a U.S. endurance record. But the accomplishment didn't make many banner headlines. And how did the doctor himself

mark that event? "I didn't," he says. "It wasn't my goal to set a record. We happened to have a press conference that day [his 84th in orbit, which broke the old U.S. record set in 1974 by the third crew of the Skylab space station] where it was mentioned, and afterwards my Mir colleagues offered me congratulations. They didn't know it before the press conference."

Equally uncelebrated was the new 16-day, 15-hour, eight-minute record for (in precise NAA-ese) Duration in a Class P Aerospacecraft, set by the space shuttle *Endeavour* last March. When that mission broke the old record of 14 days, 17 hours, 54 minutes set a year earlier by the shuttle *Columbia*, the achievement barely caused a stir, even among the seven crew members on board. Says shuttle pilot William Gregory, "John Grunsfeld [a mission specialist] and I just looked at one another and said, 'Well, we got it now.'"

A record is no longer the step up the career ziggurat it once was. After Dick Rutan broke three of the eight Absolute World Air Records with his remarkable around-the-world *Voyager* flight with Jeana Yeager in 1986, he got tons of press and a medal and a handshake from President Reagan, but when he ran for a U.S. Congressional seat in California six years later, he lost. Even John Glenn wiped out in the 1984 Democratic presidential primaries.

Though the returns keep diminishing, a battalion of pilots remain committed to blazing their way into the history books. One world class record that made it onto the NAA's most recent annual "Ten Most Memorable Record Flights" list was Ron Bower's 1994 trip around the world in a helicopter. The 24-day journey shaved five days off the record Ross Perot Jr. and copilot Jay Coburn had set in 1982. (What's more, Bower flew his Bell JetRanger solo and without the kind of elaborate assistance Ross Junior got, such as an escort from a Hercules C-130 transport with an 11-member support crew.) Another Top 10 honor went to Bruce Bohannon, who kept tweaking his 100-horsepower Formula One racer *Pushy Galore* until he was able to establish a new time-to-climb record—12 minutes and 50 seconds to reach 19,685 feet (25.56 feet per second)—at Oshkosh in 1994.



Bohannon admits he doesn't have a lot of respect for some of his fellow record setters—namely

those of us who set city-to-city records. He draws a distinction between his Oshkosh flight, which he calls a “raw performance record,” and the hundreds of city-to-city flights that fill the NAA's record book each year, many of which are made at wholly unremarkable speeds. Bohannon has a point. *Pushy Galore's* engine has 10 less horsepower than my Cessna's, yet his airplane can fly 160 mph faster. If we were racing, he would have already arrived at the hangar and begun hammering back Lone Stars.

Bohannon says that many city-to-city records are set by airline pilots who find out they're going to have a 100-knot tailwind during their flight, so they phone up the NAA, file for a record sanction, then show up at the awards ceremony to accept their plaque and give humble speeches thanking Boeing. Indeed, airline pilot speed records take up 29 pages in the NAA's latest book. Unless the course has been battled over constantly over the decades, Bohannon says, setting a national city-to-city record “is like shooting fish in a barrel with a machine gun.”

That's not the way Dick Rutan sees it. Rutan, who hopes to be the first to circumnavigate Earth in a balloon (one of the few major aeronautical milestones left), thinks all records should exist as a challenge. “People should pick up that record book and make a conscious effort to update it,” he says. “Some of these records have been around for 25 years, and that's unacceptable. Either technology's not developing or nobody cares. Both are dangerous things. If technology doesn't continue to increase, as a nation we're doomed.”

Airspeed: 100 knots. Fuel: three-quarters left tank, one-half right tank. The rain has cleared. I've left Block Island behind. To my right there's nothing but

blue sky and ocean—and plenty of whitecaps below. I had better keep a sharp eye out for boats; in case I have to ditch I want one nearby. My navigation radio now reads the Vineyard's beacon loud and clear, and the course I'm on will take me straight to the airport.

So record-setting is mainly about pushing the performance of aircraft and pilot—or is it? Well, maybe on a superficial level. According to Sel Lederman, a New York City psychologist who specializes in helping career athletes, people who set records often do it because they crave recognition. They also have higher standards than other people, and are endowed with a “critical conscience” that constantly pushes them forward. But, he adds, they tend to be rather lonely. And if they force their higher standards on loved ones or peers, that can create problems. Still, setting records “can lead to some outstanding achievements,” says Lederman. “Overall, it is a good thing. When you think of the books that have been written and the records that have been set, it has led to a better planet.”

Bruce Bohannon doesn't need a psychologist to tell him that setting records gratifies his ego. “I've got two little boys, nine and six years old, and at that age they worship their dad,” he says. “What I want to do is have my name in a book showing them that I was the best at something at some time in my life.”

Airspeed: 80 knots. The air has grown noticeably colder now, and that line of clouds is hovering ominously over the Vineyard's northern edge. With the airport in sight I skirt the island's southern shore and set up for my approach. Right now I'm the only airplane in the traffic pattern, and Tower has cleared me to land.

The air is bumpy here, gusting down the runway at 25 knots. The Spirit of Farmingdale's wings rock hard as I line the craft up with the pavement, but all my instruments and gauges are on the money. I'm coming down.

Low now, a gust tips my wing. The left

wheel makes contact, then the right, then the nosewheel. I have to brake hard to turn off in time to make the taxiway. As I'm rolling toward the tower the controller radios my official landing time: 17:58:30 Zulu. Step 5—my record flight—is officially over.

In the wonderful book *The Spirit of St. Louis*, Charles Lindbergh writes that as he lands at Paris after dark he sees to his great surprise “the entire airfield ahead is covered with running figures!” Tens of thousands of Frenchmen have broken down airport barricades and stormed past guards. They pull him from the airplane and parade him around on their shoulders until a couple of fellow pilots help him escape.

I, on the other hand, taxi to an airport ramp that's all but vacant. I am invited up to the tower to meet the two controllers there, who will fill out the requisite NAA landing form. One is excited about my record and peppers me with questions; the other rolls her eyes and couldn't care less.

A couple of weeks later the certified, embossed, seven-page official NAA dossier arrives in my mailbox. My official time for the 245.98-kilometer flight was 1 hour, 38 minutes, 29 seconds—my speed just 93.12 mph. I had a headwind, so my record won't be too tough to break—I did it myself unofficially on the return flight.

Perhaps there is a reader out there now plotting to wrench away my record, leaving me, like my fellow trailblazer Charles Lindbergh, without even a mention in the NAA's book of records. (Such is the cruel side of aeronautical fame—a “first” gets you in the book, but a faster pilot will knock you back out. The latest edition includes only the present New York-Paris record holder: Major W.R. Payne, who in 1961 made the trip in a Convair B-58 Hustler in three hours and 19 minutes.)

If you are entertaining such thoughts, let me leave you with this: After cosmonaut Yuri Gagarin made the first manned orbital flight, someone optimistically reminded a congressman that the United States wasn't far behind. The congressman bitterly replied, “Everyone remembers Lindbergh, but who remembers the second man to fly the Atlantic?” —

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The first contest for the moon was settled long before Neil Armstrong reached the lunar surface.

by T.A. Heppenheimer and Peter Gorin

In October 1957, Washington was in a panic after the launch of Sputnik I, the world's first satellite. Warning that Sputnik's powerful booster demonstrated that the Soviets held the lead in missile technology, Senator Styles Bridges called on the country "to be less concerned with the depth of pile on the new broadloom rug or the height of the tailfin on the new car, and to be more prepared to shed blood, sweat and tears." Senator Henry Jackson asked President Eisenhower to proclaim "a week of shame and danger." *Newsweek* noted that Moscow "had already given the word 'satellite' the implications of ruthless servitude," adding, "Could the crushers of Hungary be trusted with this new kind of satellite, whose implications no man could measure?"

Moscow, for its part, was about to issue a further challenge. Sergei Korolev, the head of the Soviet missile program, received this order from a senior official: "Launch a dog by the holidays." Korolev and his staff were to place a canine traveler into orbit by early November to mark the 40th anniversary of the Russian Revolution—only a few weeks ahead.

Fortunately, they already had everything they needed. They would use their standard military rocket, Semyorka, or "Number Seven," which had already propelled Sputnik I into orbit. The dog, Laika, was also ready. "Back as far as 1951, we had launched dogs into space on high-altitude rockets," one of Korolev's colleagues recalled in 1990 in an interview for a Soviet magazine. "We took the pod used for those purposes, put Laika into it, and placed it into a satellite-craft. We managed to do it just in time for the holiday." (On November 3 Laika was launched into orbit. However, when a payload shroud failed to separate, her spacecraft overheated and she died within hours.)

Korolev had one more spacecraft under construction, Sputnik III. Weighing in at close to 3,000 pounds, it would be ready to fly in a few months. But Korolev knew that after Sputnik III, it would be risky to rely on the sheer improvisation that had allowed him to set such a pace.

The Semyorka booster had been under development since 1954, not as a satellite launcher but as an intercontinental ballistic missile with the range to reach the United States. Korolev had turned it into a booster with the ability to send a payload into orbit by replacing its heavy nuclear warhead with a lightweight satellite, no more than a simple radio trans-

Sputnik, the world's first satellite, was nothing more than a polished sphere with a simple radio transmitter beeping inside (depicted here in a model). But it was enough to spark a fierce rivalry between two cold war adversaries.

MIRAGE



MATCH RACE





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In 1929 life looked good for aeronautical engineer Sergei Korolev (in cockpit, seen here with glider designer S.N. Liushin, left, and pilot K. Artseulov). But nine years later Korolev was arrested and unjustly imprisoned. After resuming his career, he launched Sputnik I from Tyuratam in 1957 (below).

mitter inside a polished sphere. Sputnik II, carrying Laika, had come right off the shelf as well. But to continue with similarly impressive feats following Sputnik III, he would need to add an upper stage to his basic Semyorka. He had the authorization to build it, but only for military purposes, and he wanted more.

In particular, Korolev wanted to shoot for the moon. "Reaching the Moon by a rocket launched from the Earth is technically possible even at the present time," he wrote in *Pravda* that December.

But standing between Korolev and the moon was his boss, minister of defense industries Dmitri Ustinov. Since he saw no need for moon travel, he turned down Korolev's request. And initially Korolev had little chance of getting past Ustinov's department. A few months earlier, he had written a report that tried to shift blame away from himself for a launch failure. A former deputy of Ustinov's, Vasily Ryabikov, had responded, "What a cunning man you are! So much stink about what others might have caused, and so much perfume for your own shit."

But in the wake of his Sputniks' successes, Korolev could go over Ustinov's

head and directly approach Premier Nikita Khrushchev, who had a strong interest in space. Following the first Sputnik, Khrushchev had told Korolev that from then on, something Soviet was to be in orbit every day to impress the world with the strength of Communism. A successful moon shot would be more impressive yet.

Korolev also had Mstislav Keldysh, a longstanding ally who was vice president of the prestigious Academy of Sciences. Keldysh had been actively involved for years with both missiles and Sputniks, and he liked Korolev's ideas. In January 1958 the two men sent a letter to the Central Committee of the Communist Party outlining their proposal. Korolev would start with a simple spacecraft that would impact the lunar surface. Later, a more demanding mission would fly past the unseen lunar far side, taking pictures with a television camera and transmitting them back to Earth.

Approval from the Central Committee came swiftly. "Comrades, we've received an order from the government to deliver the Soviet coat of arms to the moon," Korolev told his staff. "We have two years to do this." He would start by setting up two separate projects to develop an upper stage, figuring that competition would spur each group to greater effort. In particular, he wanted the upper stage's rocket engine to be ready in only nine months. That way, he could carry out his first launches in the fall of 1958, barely a year after orbiting the first Sputnik.

Meanwhile in Washington, the shock of the initial Soviet

SOVIET



successes had generated a flood of proposals for space projects. At the time there was no NASA, so to coordinate all new space efforts, Secretary of Defense Neil McElroy set up a new outfit, the Advanced Research Projects Agency (ARPA). For its director he picked Roy Johnson, General Electric's executive vice president. According to *Lunar Impact*, a book published by NASA in 1977, one of Johnson's deputies, Rear Admiral John Clark, later declared, "It seemed to me that everybody in the country had come in with a [space] proposal except Fanny Farmer Candy, and I expected them at any minute."

Johnson, like Korolev, had a strong interest in reaching the moon and saw a chance for his country to get there first. The Jet Propulsion Laboratory in California was also interested in the mission. Its director, William Pickering, had been pushing for a quickie moon shot effort called Project Red Socks. In addition, the RAND Corporation, a think tank that did work for the Air Force, had issued a report stating that this service was ready to launch a lunar probe.

Accordingly, Johnson issued ARPA's first order to the Army, calling on Wernher von Braun to carry out a version of Pickering's plan. Von Braun's star was ascendant in the U.S. capital just then, for the same reason Korolev's had risen in Moscow: He had launched the country's first satellite (Explorer 1 on January 31, 1958). ARPA's second order went to the Air Force. Like the Soviets, Johnson would try for the quickest possible action by building his moon rockets with existing technology, and by relying on the spur of competition. Both services already had new and powerful missiles of 1,500-mile range: the Air Force's Thor and the Army's Jupiter.

In addition, the nation's nascent space efforts had already brought forth two sets of suitable upper stages. Because the components of both services' moon rockets already existed, they could be ready in months rather than years. Still, those months would demand plenty of effort. For the Air Force, the center of activity lay at Space Technology Laboratories in Los Angeles, which would later become TRW. STL was already working on the principal Air Force missile programs: Thor, Atlas, Titan, and Minuteman. Now it would have to take on this new effort—and create a lunar spacecraft in the bargain.

Louis Dunn, STL's general manager, had prime responsibility. He told *Time* magazine in 1958: "I got all our people together and told them that we had taken on a new job, and that in many ways it represented the biggest challenge we had ever faced. Because while we were supposed to have this ready to fire in something like less than six months, we

could, under no circumstances, let it interfere with the Air Force ballistic missiles program. That meant, among other things, that the 40-hour week was out the window. I also told them that it would be impossible to pay overtime, that we would have to do most of this on our own time."

In this spirit, no one had time for long committee meetings. The project manager, George Mueller, was prepared to make decisions on the spot, and he kept his door open to anyone with something to say. One day, about a month before the first launch, one of his people came in with a suggestion. To increase the accuracy of the rocket's aim, the

ITAR-TASS/NOVOTO



For the honor of being the first animal in orbit, Laika paid with her life. She died when her spacecraft overheated.

man wanted to use radio tracking to precisely determine the velocity of the second stage, then send a signal at the proper moment to cut off the engine. "We made a very simple calculation," recalls George Gleghorn, who had responsibility for the second stage. "It was not studied extensively. We showed it to Mueller and he said, 'Fine. Build it.' We found an engineer, told him to design the receiver. He designed it and built it. We flew it to the Cape and put it on the second stage." (The receiver worked well during its flights.)

In Moscow the pace was similar. Russia had not yet invented the weekend; the six-day work week was standard. Even so, because Sundays were free of phone calls and interruptions for routine problems, Korolev used them for staff meetings. In addition, he imposed a rule that if his associates had to travel to the Tyuratam launch site in Kazakhstan, they could go only at night. "Korolev could not imagine wasting a working day on travel," recalled colleague Boris Rauschenbach in *Academician S.P. Korolev*, a book edited by Alek-

sandr Ishlinsky and published in Moscow in 1986. "He considered that a nearly sleepless night in an airliner's seat would give sufficient rest."

For a time, the development of the upper stage allowed little rest indeed. Not only was the design new, but it introduced a different set of technical problems as well. Following launch, the upper stage would have to ignite and start after the intense stress and vibration of the booster. Korolev had avoided these issues in his basic Semyorka, which started all its rocket engines while still on the launch pad.

Like George Mueller, Korolev stayed close to the job. Problems developed in welding the upper-stage fuel tankage, and the production engineers were soon blaming the designers. According to the Ishlinsky book, Korolev responded by summoning everyone to a meeting. "Well, what is going on?" he demanded. "Who will report? Do you understand the consequences of a delay in the tankage schedule?"

Though the Soviets had beaten them into orbit four months earlier, JPL director William Pickering, American physicist James Van Allen, and German-born engineer Wernher von Braun (left to right) were jubilant after the launch of the first U.S. satellite, Explorer 1, on January 31, 1958.

Apparently they did. A month later the welding equipment was operating properly and the propellant tanks were fully assembled. Still, even while Korolev was racing at full speed, the Yankees were beating him to the launch pad. President Eisenhower had announced his moon program late in March. "This is not science fiction," said Eisenhower. "This is a sober, realistic presentation prepared by leading scientists." Less than five months later, in mid-August, the first moon rocket, an Air Force Thor-Able, was ready for launch at Cape Canaveral in Florida.

"We literally pushed the button in those days," recalls Jim Dorrenbacher, a McDonnell Douglas engineer who took part in the countdown. "The computer didn't do it. You watched the pressure gauges, the electronics gauges, the power supply—those were tense moments. Everyone holding their breath and hoping that nothing wiggled." Following the liftoff, a number of people, including General Bernard Schriever, who headed the entire Air Force missile program, went outside the blockhouse for a better look. They watched as the rocket disappeared amid a puff of smoke in the sky.

"What happened?" Schriever asked Dolph Thiel, STL's program director. "It blew. It blew," replied Thiel, a tear rolling down his face. Allen Donovan, an STL manager responsible for the moon probe, felt "completely shot, very de-





Nine years after he worked on Pioneer 1, George Mueller was an associate administrator for NASA (here testifying before Congress about the Apollo 1 launch pad fire).

pressed. I was just in a state of shock."

Still, says Dorrenbacher, "We coped with failure by not accepting it. We simply said, 'We're better than the hardware. We're gonna get it up and running.'" Their next chance would be eight weeks later, just before Columbus Day.

Liftoff came several hours after midnight. The Thor's first stage brilliantly lit up the launch area with stark white light; then it traced a bright curving streak as it rose and turned to fly downrange. All three stages fired, and members of the launch crew threw off their reserve and erupted in joy. Still, "it probably wasn't more than five minutes into the flight before we knew we had a problem," recalls STL's Richard Booton, who was responsible for tracking the rocket. The third stage had failed to separate cleanly, throwing off the trajectory and lowering the velocity.

The spacecraft, Pioneer 1, needed a speed of 24,000 mph to get to the moon. It had fallen short by less than 500 mph. However, it was soaring high and free, eventually reaching an altitude of 70,700 miles and brushing the fringe of interplanetary space. Few people working on the project cared to sleep, not while their spacecraft continued to live, its signal returning clear and strong. Forty-three hours after launch, it reentered the atmosphere over the South Pacific, burning up like a meteor. Pioneer 1 hadn't reached the moon, but it had gone astonishingly far, and for the moment that was enough.

Indeed, this feat astounded much of the world. The Paris newspaper *La Croix* called it "the most prodigious event in history." India's Prime Minister Jawaharlal Nehru, a frequent

critic of the United States, called it "a tremendous triumph of modern science." Closer to home, Simon Ramo, a co-founder of STL, offered his own perspective on Pioneer 1: "What we gained this weekend was a few seconds on infinity."

Soon it would be Wernher von Braun's turn. Von Braun hoped to fly past the moon with Pioneer 3, a spacecraft that weighed all of 13 pounds. (Pioneer 2, launched on November 8, 1958, burned up in the atmosphere after its third stage failed to ignite.) Pioneer 3 was so small that JPL manager Dan Schneiderman carried it to the Cape by airliner, placing it in a container that occupied a seat next to his.

Pioneer 3 was launched in early December by an Army Juno II rocket. The first stage fired successfully, as did the solid-fuel upper stages. But the Juno II climbed a little too steeply and cut off its engine a few seconds early. Again the resulting velocity shortfall amounted to only hundreds of miles per hour, but again that would mean the difference between success and failure. Pioneer 3 reached a peak altitude of 63,580 miles, far short of

the moon.

Yet while the Americans were missing by seconds, Korolev was barely managing to clear the launch pad. He made his first attempt on September 23, 1958. The Semyorka's rocket engines were mounted in a cruciform arrangement, and as the booster rose, the engines made a fiery cross in the sky. But after only 92 seconds of flight, the booster disintegrated.

There were only a few days during each month when the moon was in the best position for a mission, and Korolev's second try, in October, coincided with the launch of Pioneer 1. For a brief moment it seemed that the moon race would turn into a real race, with both nations' rockets competing like Formula One cars in the Grand Prix. Hearing of the successful American launch, Korolev asked his own crew to shake off their fatigue, drink some strong tea, and continue to work. "Don't worry that the American rocket is flying to the moon," he concluded. "We will reach the moon several hours before the Americans." But a hundred seconds after liftoff, his booster again exploded and fell to Earth like a spent fireworks display. Korolev sent a team to recover the wreckage, which had fallen over a wide area of the Kazakhstan steppes. In some way, the addition of an upper stage to the basic Semyorka had rendered it unfit for flight.

Back in Moscow, he instructed his chief of ballistics, "Svet" Lavrov, to find and fix the problem. The investigation revealed that powerful oscillations within the liquid oxygen lines had torn the rocket apart. Lavrov's staff ran some experiments and developed a mathematical model, concluding that they could cure the oscillations by installing damping devices in the oxygen lines. By the end of 1958, the modified booster was ready.

Korolev's flight failures, coupled with America's near-suc-

cesses, had put him under considerable pressure. But he never wavered, perhaps because he had known far darker days as a political prisoner, or *zek*, under Joseph Stalin's rule. As a senior engineer at the Scientific Research Institute of Reaction Propulsion, Korolev had had a successful career designing and building small, liquid-fueled rockets. But in 1938 Stalin's secret police, the NKVD, arrested him on trumped-up charges of sabotage. Forced to leave his wife and daughter, he spent six years in prisons and slave labor camps. A four-month stay at a Siberian mining camp nearly killed him, but his luck turned when he was transferred to another prison camp—this one an aeronautical design group staffed entirely by *zeks* (including aviation luminary Andrei N. Tupolev). Korolev eventually moved to a prison design

In September 1959 Premier Khrushchev visited the U.S. for a summit with President Eisenhower. While Khrushchev (left) and his wife posed for the cameras with Eisenhower and Soviet foreign minister Andrei Gromyko, Luna 2 was stunning the world with a dazzling journey to the moon.



MIRAGENCY

bureau that was building rockets, where his contributions were substantial enough to win his freedom in 1944.

Millions of *zeks* never made it out of prison alive; fortunately, Korolev's ability to bury himself in his work had sustained him. One day he and a fellow prisoner were listening to a violin concerto on the radio, and they both became very homesick. "Tears ran down my cheeks," recalled the prisoner in *Three Paces Beyond the Horizon*, a book published in Moscow in 1989. "And I looked round to see Korolev standing beside me with tears in his eyes too. I began to cry most bitterly. He went back into the office, and when I returned, he was sitting at his desk absorbed in his task."

Fourteen years after his imprisonment, Korolev's absorption in his work had in no way diminished. At times it seemed intimidating to those working under his supervision. While visiting the shop where workers were securing the lunar spacecraft to its mounting frame, he heard a hammering sound. A staff member had run into stuck bolts on the frame and was trying to loosen them by pounding them with a heavy wrench. "What on Earth are you doing!" yelled Korolev. "Why are you pounding it? This is a spacecraft!" The worker tried to explain that he had been pounding the mounting frame, not the payload itself, but Korolev would not listen. He cooled down only when the man pledged that he would never do it again.

Just before Christmas, Korolev came to the Tyuratam launch site with Mstislav Keldysh in tow. The weather was severe, with temperatures falling to 20 below zero. Heating pipes broke in a hostel, and makeshift stoves produced so much smoke that people found it hard to breathe. Workers at the launch pad wore heavy coats and fur-lined boots, but these offered little protection against the freezing wind. To make matters worse, problems cropped up in the radio systems, delaying the launch. Many of the workers sought relief in alcohol, but since a government commission was about to arrive, Korolev would not permit drinking. Once the commissioners left, however, a logistics officer approached him with a silent question in his eyes. "To hell with it," said Korolev. "Give it away." Within minutes the workers had lined up at a supply shed, armed with teakettles to carry away the hooch.

The new year brought a holiday, but Korolev returned to the pad that day and the next. The wind had gone and the weather was a little warmer. Korolev was in his element. As reported by Yaroslav Golovanov in his 1994 book *Korolev: Facts and Myths*, Korolev listened with pleasure to the familiar sounds of hissing pneumatic lines, rumbling electric motors, whining generators, and valves slapping closed. Oh



God, he thought. Everything is in order, on schedule, and the people around me are just beautiful.

The liftoff was also beautiful: This time the entire booster, including the upper stage, performed flawlessly. Very soon the probe, Luna 1, sailed into space, reaching well beyond the altitudes of Pioneers 1 and 3. It approached the moon, then passed it closely.

But as Korolev returned to Moscow, he felt gloomy. He had not planned to fly past the moon; he wanted to hit it with a direct impact.

In Moscow, however, the mood was upbeat. Everyone declared that he had scored a major success, for he had built the first rocket to achieve the velocity needed to escape Earth's gravity. Luna 1 had made a mark, even if it wasn't on the moon. Inadvertently, it had become the first spacecraft to enter an orbit around the sun.

Two months later von Braun matched this feat with Pioneer 4. But his achievement wasn't really comparable, for his spacecraft weighed only 13 pounds, compared with the nearly 800-pound Luna 1. According to the Golovanov book, when Korolev was studying Germany's wartime V-2 rockets 13 years earlier, he had boasted, "Just wait—we'll outrun

NASA (2)



On December 6, 1958, the Army launched a Juno II rocket from Cape Canaveral (left) with the goal of hurling a tiny probe, Pioneer 3 (above), past the moon.

that fop von Braun!" Now he had done so twice within 18 months: first with Sputnik I and now with Luna 1.

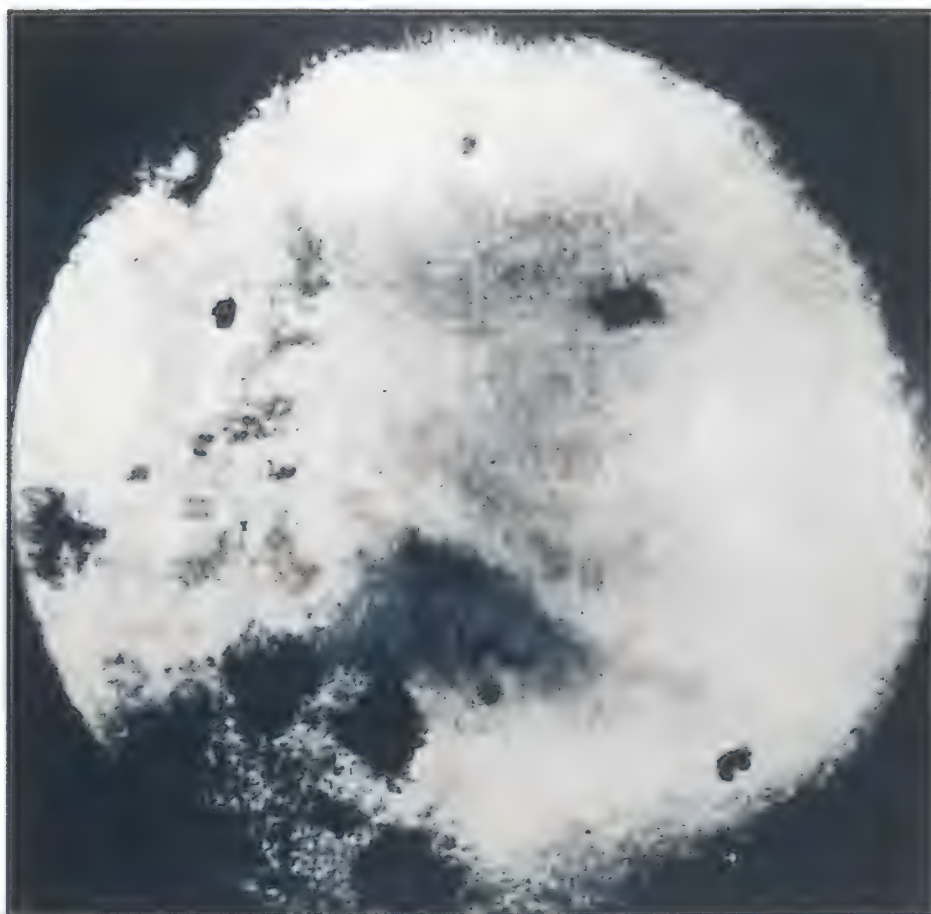
But Korolev wouldn't rest on his laurels. Already he was preparing to use his rocket's power to carry out the most demanding mission yet. He would seek to photograph the lunar far side, which no one had ever seen.

This mission would call for a spacecraft with unusually advanced capabilities. It would have to follow a trajectory of high accuracy—Luna 1's near-miss wouldn't do. It would also have to orient itself while behind the moon, locating it with a sensor and pointing its camera in the proper direction. It would then have to operate a photo lab, developing the film by washing it in chemicals. In response to a radioed command from a ground station, the spacecraft would then turn on a TV camera, scan the developed photos, and transmit the images back to Earth.

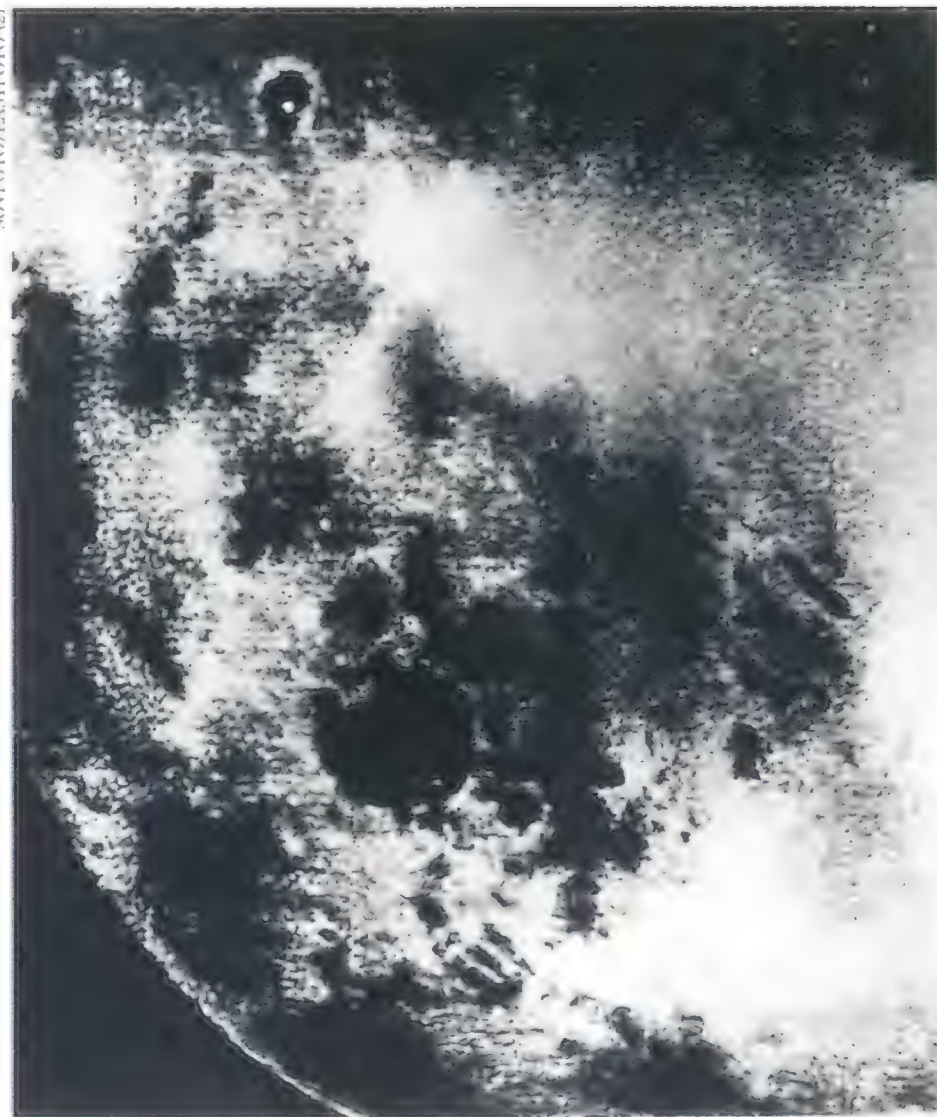
To develop the orientation system, Korolev turned to colleague Boris Rauschenbach, who had worked with him on developing the upper stage that propelled Luna 1 toward the moon. Rauschenbach started by borrowing a thousand rubles and sending one of his engineers to a local hobby shop to load up on second-hand electronic components. Soon his staff was building optical sensors, attitude control jets with compressed nitrogen, gyroscopes, and electronic controls.

After the complete system had been assembled within the spacecraft, Rauschenbach's group set about seeing if it would work. As reported by a 1991 issue of *Aviatsiya i Kosmonavtika*, a rope was attached to the satellite, and a crane lifted the rope. Someone activated the onboard batteries. Powerful searchlights flashed from the far end of the test area. Then the spacecraft, its surface covered with shiny solar cells, turned slowly on the rope like a glitter ball at a disco, sparkling in the bright light and casting brilliant reflections onto the walls.

In 1959 Luna 3's camera photographed the moon and transmitted 17 usable images back to Earth. The quality may seem poor by today's standards, but the photographs gave the world its first peek at the far side of the moon.



SOVPHOTO/EASTPHOTO (2)



And that's all it did. A solar sensor was supposed to pick up the searchlights, but that didn't happen. Someone suggested bringing the lights closer. Workers brought them so close the spacecraft began to get hot. Still nothing. The searchlights were turned off and then a furious discussion ensued.

Then an engineer lit a match close to a solar detector. Immediately there was a loud hiss from an attitude control thruster, and the craft slowly turned toward the tiny flame. "We would have to launch you and your matches into space," said a disgusted Korolev. Later tests showed that the solar detectors were insensitive to the wavelengths of the searchlights. But they would pick up the sun nicely.

Korolev proceeded to orchestrate a one-two punch at the moon. In September 1959 Khrushchev was visiting the United States for a summit meeting with Eisenhower, and he was eager for a propaganda victory. Korolev responded with another rocket to the moon. Moreover, he arranged for announcements about the mission's status to come not from Moscow but from Britain's great radio observatory at Jodrell Bank. The observatory had the world's largest radio telescope, and its director, Sir Bernard Lovell, held an unsurpassed reputation that would add luster to the achievement.

The Soviets had been carrying out their space program amid considerable secrecy, hiding their failures and brandishing their successes. Lovell, for his part, had worked closely with the Air Force amid preparations for its Pioneers, but had met stony silence when he had sought to work with the Russians. But as soon as it was clear that this latest moon rocket had fired successfully, Moscow announced that it was

on its way. Still, they hedged a little. Unwilling to state in advance that the goal was to hit the moon, they used the Russian preposition *k*, which means both "to" and "toward." If this probe, like Luna 1, missed, then the second translation would become the operative one.

Lovell was on his way to a cricket match when a newsman got hold of him and asked what he was going to do about the moon probe. He replied that he was going to play cricket (the spacecraft, Luna 2, would not reach the moon for over 30 hours). Lovell returned to his office after the game and found a telex from Moscow giving the data he would need to track it. Luna 2 speeded up as it entered the lunar gravitational field, producing a Doppler shift in its transmitter's frequency. Soon, with Lovell's great telescope pointing directly at the moon, Luna 2 struck near the crater Autolycus, and its transmitter cut off sharply.

Referring to its unusual accuracy, Korolev's biographer, Yaroslav Golovanov, compared the feat to shooting a bird from an airplane in flight. Lovell, meanwhile, had his own assessment, which was reported by *Time* magazine: "Simply astonishing, and the mind just boggles."

Then in early October, on the second anniversary of Sputnik I, Korolev followed with his second punch, unleashing Luna 3. As this probe passed over the moon's south polar region, its sensors picked up the sun. The spacecraft turned its bottom in that direction, remaining locked on the sun as the moon moved into view of another set of sensors, located on the probe's top. Responding to them, the craft now turned to face the moon, locking on it and shutting off its sun sensors. Then it proceeded to take 29 photographs of

the moon's far side. It ran the film through its automated processor, which Korolev's staff called the "laundromat" or the "public washroom." With the film developed, Luna 3 stood by to scan the images with a facsimile system at 1,000 lines per frame, then transmit them to a ground station at Simeiz in the Crimea.

Now soaring high over the moon's north pole, the craft began a return to Earth along a carefully planned orbit that would keep it in the tracking station's view at all times. Because Luna 3's transmitter lacked the strength to send a clear signal at lunar distances, it would transmit when it drew closer to Earth. Like any tourists then, the staff would have to wait a while to see how their photos turned out.

Even while Luna 3 was too far away for a successful transmission, the impatient controllers decided to make an attempt by sending up the appropriate commands. "We were sitting in the dark control room staring at the screen of a monitor," recalled team member Aleksandr Kashits in *Aviatsiya i Kosmonavtika*. "Again and again we were trying to see, or rather to guess, at least a hint of the picture." The screen, however, showed nothing. Nor did it show anything during a second attempt, and a third.

Korolev was staying in the Black Sea resort town of Oreanda. He tried to relieve his impatience with frequent walks, knowing there was nothing he could do to bring the photos any faster. According to the Golovanov book, he even kept his temper when an associate warned him, "I can assure you that there would be no pictures. The radiation of space would destroy any image."

To reduce any radio interference, authorities closed the coast road near the ground station and instructed passing ships to maintain radio silence. But a fourth attempt to receive a transmission yielded nothing. Then, with hope fading, everyone gathered for a fifth try. As reported by Golovanov, a lunar disk slowly appeared on the screen. Soon the

first test print came in from the Simeiz photo lab. "Well, what do we have here?" said Korolev, taking the print in his hand. It was foggy and indistinct. "Don't worry," said one of his colleagues. "We'll add some filters and remove distortions." Only two photos were received during that session, but as Luna 3's signal grew stronger, it eventually delivered 17 usable images out of the 29 taken.

Overall, the American press reacted to the Soviet successes with admirable sportsmanship. "Certainly all humanity joins today in congratulations to those responsible for this achievement," read a *New York Times* editorial about Luna 2. "The Soviet people have a right to be proud." Six weeks later, a *Washington Post* editorial noted Luna 3's "glory" and "triumph."

Those involved in the U.S. lunar program, however, felt sadness and regret. "I was just unhappy we hadn't gotten there first," says George Mueller. "That was a period when the [U.S.] political apparatus was trying to decide whether space was important or not. At that time, they were trying to convince themselves and the rest of the nation that it didn't make any difference whether the Russians got to the moon because the important thing was how many ballistic missiles you had." But Mueller felt strongly that "the most important single thing we could do was to get into space in a way that would demonstrate our capabilities." Jim Dorrenbacher, who also worked on Pioneer 1, shared his sentiments. "We all felt disappointed that it took us so long to get started," he says. "We all knew we could accomplish similar things."

As for Korolev, his lunar triumphs brought him personal satisfaction but little of the kind of public accolades heaped on Wernher von Braun. Since Korolev gave no press conferences and didn't publish, except for rare pseudonymous articles for *Pravda*, his name was unknown even to his countrymen. He never won the right to travel abroad, though he was allowed to join the Communist Party, which showed that

his reputation had been restored following his imprisonment. He also won membership in the prestigious Academy of Sciences and lived in a spacious home. But none of these privileges was enough to make him forget the injustice of his arrest. "There was no investigation in the proper sense of the word," Korolev would later report. "I was bluntly accused of sabotaging research in new technology. I could not imagine a more absurd and incredible charge."

In 1966, at the age of 59, Korolev died following surgery for cancer. He had led the drive into space, and after his death he would receive ample recognition for his work. But while he lived, always in the shadow of the secret police, he never ceased to feel like a *zek*. ➤

In the twilight of his career, Korolev (right) launched Yuri Gagarin into orbit on April 12, 1961, nearly a year before the U.S. would orbit John Glenn.



RIANOVOSTI/SONFOTO





>SIGHTINGS<

How did he do that? That's a common reaction to the work of Craig M. Wilson, whose photographs are taken from seemingly unattainable perspectives. Wilson's secret weapon is the kite. "My goal with aerial kite photography is to take my camera to very unusual vantage points to eavesdrop on the world," says the Madison, Wisconsin photographer. "I control the elevation, aiming, and shutter release of the camera by radio controls utilizing lightweight gears, motors, and switches while I remain standing on the ground separated by hundreds of feet from the camera."

While Wilson is not the first to use kites and cameras (see "The Hitherto Impossible in Photography is Our Speciality," Oct./Nov. 1988), his photographs provide a sense of surprise and delight, whether they're showing us kites'-eye views of a ferris wheel or the sculpted Marines of the Iwo Jima memorial outside Washington, D.C.



China Pilots



COURTESY FELIX SMITH

From Felix Smith's *China Pilot*: A CAT C-46 flies over a walled village in northern China.

Sharks Over China: The 23rd Fighter Group in World War II by Carl Molesworth. Brassey's, 1994. 325 pp., b&w photos, \$24 (hardcover).

Chennault's Forgotten Warriors: The Saga of the 308th Bomb Group in China by Carroll V. Glines. Schiffer, 1995. 343 pp., b&w photos, \$29.95 (hardcover).

China Pilot: Flying for Chiang and Chennault by Felix Smith. Brassey's, 1995. 309 pp., b&w photos, \$24.95 (hardcover).

Claire Chennault's legend just keeps on growing. Last year provided a feast for readers who can't get enough of the man who led the Flying Tigers, the 14th Air Force, and the cargo line that became the CIA's Air America.

In *Sharks Over China*, Carl Molesworth tells the story of the Army pilots who



replaced the Tigers in 1942. His book has been out for a while but deserves mention for its meticulous chronicle of the 23rd Fighter Group—the closest thing to a guerrilla air force the world has ever seen.

In addition to P-40 fighters, Chennault had a few Consolidated B-24 Liberators, which hauled their own gasoline and bombs "over the Hump" from India to China. He gave them a theater of operations bigger than that of the entire Eighth Air Force in Europe. Probably because so little has been written about the 308th Bomb Group, Carroll Glines' account, *Chennault's Forgotten Warriors*, isn't really a history but more a collection of yarns, like the chapbooks published by veterans of a campaign.

Felix Smith isn't a historian at all. He's a pilot—a good one, to have survived 23 years with Civil Air Transport. CAT was organized to carry relief supplies around postwar China, only to become a paramilitary arm of Chiang Kai-shek's campaign against communism.

To our great good fortune, Smith also turns out to be a gifted reporter. Better than anyone else, he evokes the sights, smells, and sounds of China in 1945. He



also ably describes the effects of an economy so weak that precious U.S. dollars were washed and ironed after use, and a government so depraved that it's a wonder it lasted until 1949. Smith makes the reader fume with the

CAT pilots stuck in the clouds, hostage to a Chinese Air Force officer who shut down their radio beacon until he got all the cash in the airline's safe.

Smith also evokes the beauty of Asia, and of flight. Here we go to Lanzhou:

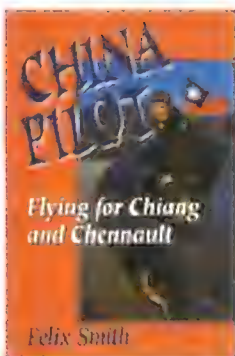
For the Kids

3-D Wings: Fabulous Flying Machines by Rick Sammon. Thomasson-Grant, 1995. 28 pp., including 12 3-D photographs and viewing "goggles." \$11.95 (hardcover).



With the red- and green-lensed paper goggles glued inside the front cover of this book, children from six

to 12 can see three-dimensional images of a number of early aircraft from the collection at the Old Rhinebeck Aerodrome in New York. Younger children may need a grownup to explain some of the text.



"Our shadow, circled by a rainbow, ran along with us until the clouds broke up over mountains, and we saw a valley of the Yellow River and Sian. Another two hours put us within sight of giant waterwheels near a city of wide streets and rows of poplar trees and an encircling wall that was twenty feet thick and bristled with parapets and watch towers." I haven't enjoyed a trip so much since I was a fifth grader, reading Richard Halliburton instead of my geography.

Exiled to Taiwan after Chiang was defeated, CAT became a subcontractor to the United States' CIA. Among other covert operations, its pilots helped supply French garrisons in Vietnam. Smith flew in those desperate airlifts, along with the likes of James McGovern—"Earthquake Magoon"—an oversized and joyful man, killed the day before the French surrendered Dien Bien Phu and lost their Vietnam war.

China Pilot is a wonderful book. It belongs on the shelf of every admirer of Chennault and his unorthodox air forces.

—Daniel Ford wrote *Flying Tigers: Claire Chennault and the American Volunteer Group* (Smithsonian Institution Press, 1991).

VIDEO

The Wings of Honneamise, written and directed by Hiroyuki Yamaga. Manga Entertainment (available through major video and music outlets). \$19.95 dubbed, \$24.95 with subtitles.



If the Japanese *animé* cartoon style is unfamiliar to you, just ask your kids; it's what they watch. This two-hour spectacular feat of animation tells the tale of a young flying cadet who ends up in the space program on an imaginary world where two great powers are at the brink of war. We won't spoil the ending for you—we haven't figured it out yet. In fact, forget about the storyline and focus on the art of this style of "cartoon," as well as the fanciful interpretations of aircraft and spacecraft, all inspired by a visit to NASM by the team of artists who produced this film.

—George C. Larson is the editor of *Air & Space*/Smithsonian.

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The Shoulders of Giants: A History of Human Flight to 1919 by Phil Scott.
Addison-Wesley, 1995. 337 pp., b&w
photos. \$24.00 (hardcover).

The storyline is familiar: the achievement of one of humanity's oldest dreams, the ability to fly. The cast of characters is, for the most part, predictable: Daedalus, Icarus, Leonardo da Vinci, the Montgolfiers, Langley, Chanute, Blériot, Curtiss. The Wright brothers are properly at the center of Phil Scott's account, exemplifying the insights about aerial navigation that had accumulated by 1900 and serving as a benchmark by which to judge the extraordinarily rapid progress of the 16-year period that followed the brothers' first successful flight in December 1903. Alcock and Brown's 17-hour crossing of the Atlantic in June 1919, the author tells us, was 83,160 times the distance of Orville Wright's historic 12-second hop at Kitty Hawk.

Scott's strength does not reside so much in the discovery of new material or even the synthesis of insights available in the work of others. On the contrary, judging by his list of sources, his research was quite haphazard. But he does provide infectious enthusiasm, supercharged prose, a journalist's eye for amusing anecdotes, and a fine sense for the details



of aircraft construction in its early days. Indeed, he is at his best when explaining the purpose and position of the planes and elevators, the spars and struts, the ailerons and rudders, the wire and silk cloth, the

harnesses and controls, with which the earliest flying machines were equipped. He understands what makes an airplane fly and how the camber of a wing can make a difference.

Students of aviation history may find assertions here and there that raise an eyebrow and marvel at the ease with which Scott glides over controversies that have generated stacks of print. But the ordinary reader can look forward to a thoroughly pleasurable and generally well-informed excursion through the history of aviation up to 1919. The charm of Scott's high-spirited narrative is such that one ends the book wishing for more.

—Robert Wohl teaches history at the University of California at Los Angeles. He is the author of *A Passion for Wings: Aviation and the Western Imagination, 1908-1918* (Yale University Press, 1994).

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The Physics of Star Trek by Lawrence M. Krauss (foreword by Stephen Hawking). Basic Books, 1995. 188 pp., \$18.50 (hardcover).

Is there anything Star Trek can't teach us? A year or so ago a tongue-in-cheek self-help book appeared called *All I Need to Know I Learned from Star Trek*. Last year the tongue moved from cheek with *Make It So*, a book of leadership techniques derived from the Trek franchise. That was followed by *Boldly Live As You've Never Lived Before*, a volume of Star Trek's life lessons.

That's got life covered. Now Lawrence M. Krauss, a professor of physics and astronomy at Case Western Reserve University, uses Star Trek as a springboard to teach us about the universe and everything in *The Physics of Star Trek*. Offering up as many helpings of Einstein as of Kirk, the book provides



readers with literate, understandable explanations about the basic stuff of the universe.

Is the physics of Star Trek feasible? Some is, some isn't, says Krauss. The warp drive, while not

impossible, "hinges on a remote possibility." And as for the transporter, "probably no single piece of science fiction technology aboard the *Enterprise* is so utterly implausible." To obey the simple command "Beam me up, Scotty," the transporter would have to "heat up matter to a temperature a million times the temperature of the Sun, expend more energy in a single machine than all of humanity presently uses, build telescopes larger than the size of the Earth, improve present computers by a factor of 1000 billion billion, and avoid the laws of quantum mechanics." Other than that, it's a piece of cake.

Nonetheless, Krauss tips his hat to the Star Trek writers' attempts to base their technology on scientific principles, even going so far as to create "inertial dampers" for the engines and Doppler and Heisenberg compensators for the transporters.

While non-fans can learn much about physics, they may be baffled by Krauss' Trek references. "For example, without the economic importance of dilithium, the *Enterprise* would never have been sent to the Halkan system to secure its mining rights, and we would never have been treated to the 'mirror universe,' in which the Federation is an evil empire," Krauss writes in his discussion of warp drive

power sources. For some, this language will be more arcane than that of quantum mechanics. But the book is fun to read, because Krauss takes Star Trek seriously without getting ponderous or silly.

The most fascinating stuff in the book, however, is not the fiction, it's the science. For example, when discussing rotating pulsar stars, Krauss writes, "This means that an object that is essentially a huge atomic nucleus with the mass of the Sun and 10 to 20 kilometers across is rotating over 1000 times each second. Think about that." And I did.

—Tom Huntington is the managing editor of Air & Space/Smithsonian.

Building the B-29 by Jacob Vander Meulen. Smithsonian Institution Press, 1995. 104 pp., b&w photos and drawings, \$18.95 (hardcover).

What is most astonishing about the Boeing B-29 is that the U.S. Army asked for it in 1937. The Army wanted a super-bomber in peacetime, and the company designed it as a private venture. Not until 1940 was there an actual contract—and that was for only two airplanes. Eventually the fleet would number 3,895 at a cost of \$3 billion, making the B-29 more

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expensive than any other weapon of World War II, not excluding the atomic bomb.

In *Building the B-29*, Jacob Vander Meulen is less interested in the weapon than in the industrial phenomenon—the B-29 as product of a nation emerging from depression and despair to find itself the most powerful in the world. Of four factories that built it, the most successful was in Wichita, Kansas. It offered good weather, level ground, security from foreign raiders, and thousands of patriotic, hard-working people with few



job opportunities. The magnitude of a \$3 billion program in those days can be gauged by the cost of a meal at

Boeing-Wichita (28 cents, including soup, coffee, and pie) and by the hourly wage (75 cents). You worked 10 hours a day for 12 days, then got two days off. Including overtime, you earned \$52.50 a week on the average, before payroll deductions. (Like the Pentagon, Muzak, the preeminence of Boeing as an airframe builder, and even many of our airports and factories, the withholding tax was a product of the war machine that the United States became during the war.)

As a historian of economics, Vander Meulen brings a refreshing perspective to these developments. He concludes with this arithmetic: For every ton of explosives dropped by a B-29 on Japan, an American worked 3.4 years to get it there, and a Japanese worked 50 years to repair the damage.

—Daniel Ford wrote about the last B-29 raid of World War II in the Aug./Sept. 1995 issue.

On the Web

Want to read reviews of aircraft performances? Check out Jeff Ethell's Pireps (that's shorthand for "pilot reports") at *Air & Space* magazine's Web Site (<http://www.airspacemag.com/JE-Pireps/JE-menu.html>) and get first-hand descriptions of what it's like to fly everything from a Fokker Dr.1 Triplane to an F-16. Those wishing to sample Ethell's writing in a more traditional format (on paper) can order some of his books through the Web Site's Aerospace Marketplace.

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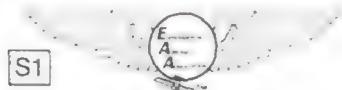
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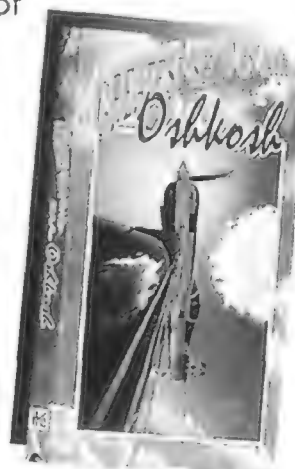
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Spaceflight and Rocketry: A Chronology by David Baker. *Facts on File, Inc.*, 1996. 560 pp., b&w photographs. \$65.00 (hardcover).

Starting in 360 B.C. ("The earliest recorded application of action and reaction was embodied in a toy described by Aulus Gellius in his *Noctes articae* as the ancient pigeon of Archytas") and ending in December 1993 ("The White House asked industry and users for input by January 14, 1994 on U.S. launch vehicle development to support a report the Office of Science and Technology Policy was preparing"), Baker presents readable descriptions of events in rocketry history: not just the launches and missions but also the policy decisions.

Luftwaffe Codes, Markings & Units, 1939-1945 by Barry C. Rosch. *Schiffer Publishing Ltd.*, 1995. 444 pp., b&w photographs and illustrations. \$59.95 (hardcover).

Although the general reader may enjoy the many photographs, this is

really intended for the researcher. It's unfortunate that the many side views showing airplane paint schemes couldn't be rendered in color.

Dictionary of American Naval Aviation Squadrons—Volume 1: The History of VA, VAH, VAK, VAL, VAP and VFA Squadrons by Roy A. Grossnick. *Naval Historical Center*, 1995. 562 pp., b&w photographs, \$46.00 (hardcover).

This hefty tome includes Squadron histories, commanding officers, aircraft used, insignia, awards received... Those interested in this exhaustive look at Naval aviation can also get it on a CD-ROM.

The Sky Their Battlefield by Trevor Henshaw. *Grub Street*, 1995. 618 pp., b&w photographs, \$69.95 (hardcover).

A record of all American, British, and Commonwealth air combat casualties from World War I. It also includes a day-by-day combat report

for the aerial engagements that occurred during the first year and a half of the war.

Allied Aircraft Piston Engines of World War II by Graham White. *Society of Automotive Engineers*, 1995. 426 pp., b&w photos and extensive diagrams and mechanical drawings, \$39.00/\$35.00 (member price), hardcover.

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The development of aircraft, when compared to that of engines, seems to take place at a relatively brisk pace. Engines simply take longer, and perhaps that's why

definitive books on the subject seem to appear about once in a generation. This is one of those. If you are serious about your aviation library, you will need this generous volume, which describes those monsters you now have to pay to hear at airshows. And in loving detail too, with numerous photographs and diagrams from the National Air and Space Museum archives.

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CREDITS

At Wicks' End. Arnold Benson has been writing advertising copy since World War II. He has also written short stories, essays, and features for *Esquire*, the *New York Times*, and *Sports Illustrated*. His last piece for this magazine was "Speech Lesson" (Feb./Mar. 1995).

Apollo 13 II. Ellis Weiner is executive story editor of the PBS children's series "The Puzzle Place."

The Oil Route. A resident of Avon, Montana, Tom Harpole is a frequent contributor to *Air & Space/Smithsonian*. His piece about the lives of American F-16 pilots based at the Kunsan Air Base in South Korea appeared in the June/July 1994 issue.

A resident of Marin County, California, photographer Geoffrey Clifford was a combat helicopter pilot in the Vietnam war. He has returned to Vietnam 12 times, and in 1989 he published *Vietnam: The Land We Never Knew* (Chronicle Books).

The Big 10: Counting Down the Winners. Dee Mosteller has been involved in aviation in one form or another for most of her life. She had her first airplane ride at age 13; six years later she went up again—this time sitting in the left seat. She has written for numerous publications, specializing in aerospace, scuba diving, and health.

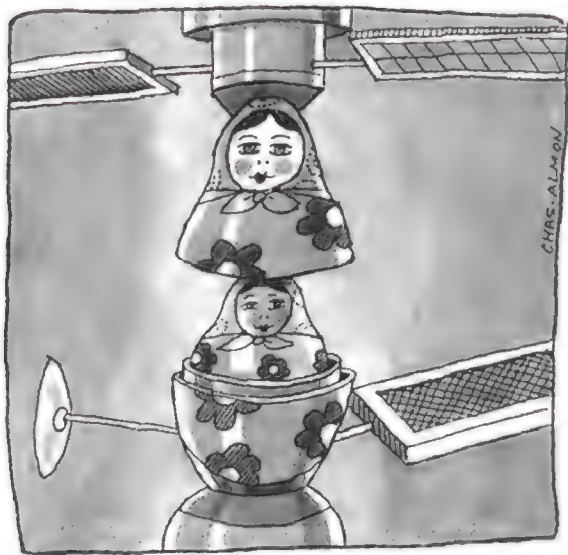
The Rise and Fall of the East German Aircraft Industry. Fred Stahl works in technology and manufacturing for McDonnell Douglas. He learned of the Dresden story while posted in Europe from 1989 to 1993.

American photojournalist Mark Simon has been living in Berlin since 1992. He is working on a book about racism and extremism.



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Seeing Stars. Tony Reichhardt is a frequent contributor to *Air & Space/Smithsonian*. His last feature was "Look! Up in the Sky!" (Aug./Sept. 1995).

Further reading: "Untwinkling the Stars—Part I and Part II," Robert Q. Fugate and Walter J. Wild, *Sky & Telescope*, May and June 1994.

"Adaptive Optics," John W. Hardy, *Scientific American*, June 1994.

Photographer Roger Ressmeyer is an editor at the Corbis Corporation, a digital photo archive. Ressmeyer became fascinated with space shortly after his eighth birthday, when John Glenn became the first American to orbit Earth. Three years later, Ressmeyer was making his own telescopes and photographing the heavens.

So You Want to Set a Record.... When Phil "The Lone Beagle" Scott is not making aeronautical history, he works as a freelance writer in New York City. His book on the early days of flight, *The Shoulders of Giants*, was published last year by Addison-Wesley.

David Peters is a computer illustrator based in Venice, California. He created the Aerocar cover for the previous issue.

Match Race. Science and aerospace writer T.A. Heppenheimer is the author of *Turbulent Skies: The History of Commercial Flight* (John Wiley & Sons, 1995), which was reviewed in the Dec. 1995/Jan. 1996 issue.

Peter Gorin is a historian of Russian aerospace and an international trade consultant. A former Soviet political analyst, Gorin moved to the United States in 1990.

Airships to Spaceships. Tim Kincaid works for the American Airlines corporate communications department. He is the newsletter editor for the Vintage Flying Museum at Fort Worth Meacham Field.

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7th Annual Conference of Women in Aviation, International. Over 1,500 participants and some 75 exhibitors expected, including representatives from general, commercial, and military aviation. Minneapolis Hilton and Towers, Minneapolis, MN, (513) 225-9440.

March 23

Spring Break Fly-In and Aircraft Swap Meet. Air Victory Museum, South Jersey Regional Airport, Medford, NJ, (609) 520-4561.

March 25-28

"Mutual Concerns of Air and Space Museums" Seminar. For museum professionals only. For more information, contact Helen McMahon at the National Air and Space Museum, Washington, DC, (202) 357-4473.

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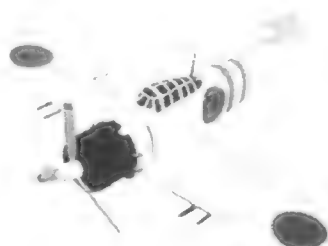
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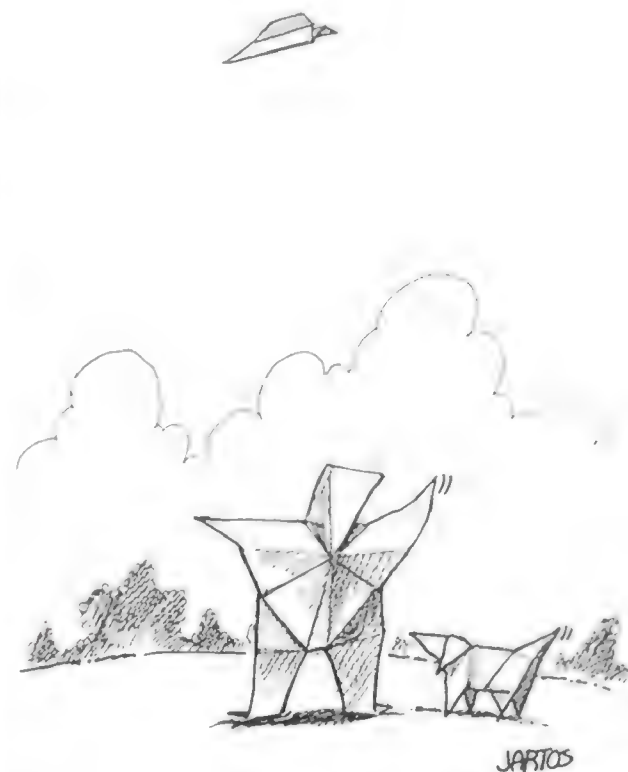
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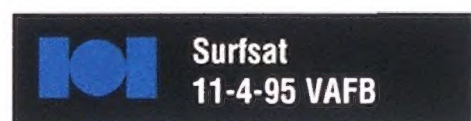


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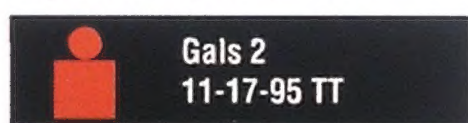
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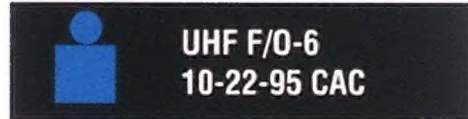


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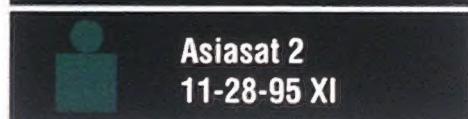
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STS-74 U.S. research 11-12-95 down 11-20-95

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FORECAST

In the Wings...

Air & Space/Smithsonian celebrates its 10th anniversary. In the next issue a special collection of features will dramatize what the span of 10 years has meant to the development of aviation and spaceflight at crucial stages in their histories.

1913: The Dominance of France. Ten years after the Wright brothers' first flight, the capital of aviation had moved from the United States to Paris. Through the brilliance of Louis Blériot and the flamboyance of Armand Deperdussin, the French monoplane emerged as the shape of aviation's future.

1937: Assault on the Atlantic. Charles Lindbergh proved it could be done in 1927, but 10 years later the Atlantic Ocean was granting passage only to mailplanes and lone adventurers.

1949: Bomber at the Crossroads. Ten years after the first jet flight, jet engine technology had matured enough to offer the speed but not the range to fight the cold war. The struggle to move from propellers to jets was exemplified by the U.S. Air Force's deployment of the Convair B-36 Peacemaker, a whale of a

bomber that started out with six Pratt & Whitney Wasp Major pusher engines and later got an additional four turbojets.

PLUS—Full-Color Poster: The B-36. Another *Air & Space* collectible will feature the B-36 as well as two other hybrid aircraft, the Ryan FR-1 Fireball and the North American AJ-1 Savage.

1967: Entertaining the Global Village. A two-hour black-and-white television show took the phrase "live via satellite" to a new level of achievement with transmissions from 14 nations. The "Our World" broadcast made clear, 10 years after the launch of Sputnik, that satellites had a role in show biz.

1979: The Triumph of Ariane. Still buoyed by their 1969 Apollo victory, the Americans were about to take the launch market by storm with a revolutionary reusable launch vehicle. Why then did Europe, led by the French, succeed with the much less innovative Ariane?

1996: Thiokol's Recovery. Under the shadow of the 1986 *Challenger* disaster, the employees of Thiokol Corporation have continued the dazzling work of building, recovering, and refurbishing the space shuttle's solid rocket boosters.

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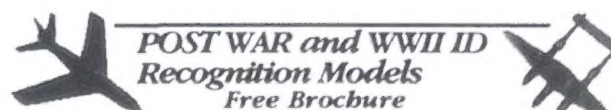
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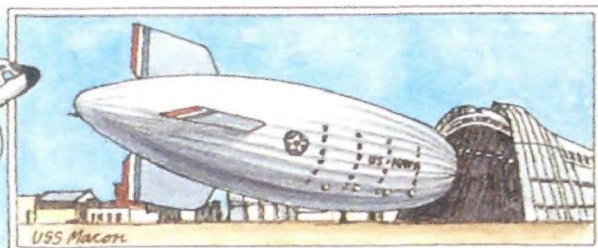
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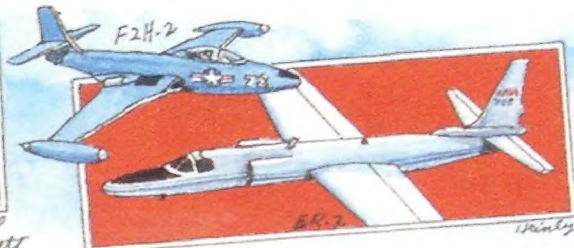
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Airships to Spaceships

During the Depression, the communities of the San Francisco Bay Area came up with a scheme to create jobs and boost the local economy. The U.S. Navy was looking for a site to base an enormous dirigible, the USS *Macon*, and the communities decided to try luring the Navy with a donation of 1,000 acres of land between Mountain View and Sunnyvale. The plan worked, and starting in 1932, residents living around the new base began to see the 785-foot *Macon* and, occasionally, its sister ship, the *Akron*, passing serenely overhead. Rose Lesslie grew up in Mountain View, and she recalls: "They were so beautiful and huge, and also made a huge impact on this area." Recently, Lesslie got a chance to share those memories when she helped put together the Moffett Field Museum, which documents the base's history of distinctive flying.

Though the U.S. military lost interest in rigid airships in 1935, when the *Macon* crashed in a squall off Point Sur, over the years it kept finding uses for the airship's base. The U.S. Army used it as a West Coast base for pursuit squadrons and for training air cadets (actor Jimmy Stewart received a commission as a second lieutenant there). After Pearl Harbor was attacked, the U.S. Navy again took command of the base, naming it after Rear Admiral William A. Moffett, who had championed the original dirigibles. Sailors at Moffett Field learned how to use non-rigid airships—blimps—to patrol the Pacific coastline for enemy craft.

The Moffett museum displays an eclectic collection of items sporting images of airships, such as produce crates and wine bottles from a local vineyard. Other lighter-than-air artifacts include a large wicker basket from a balloon used in airship training, a life preserver autographed by all 83 *Macon* crash survivors, and a propeller from the L-8 blimp, which mysteriously landed in nearby Daly City in 1942 without a trace of the two men who had taken it up.

In 1947, with the war over and the Jet

Age beginning, Moffett's involvement in lighter-than-air craft came to an end. The base went on to house Navy transports and the fighters that flew from Pacific-based aircraft carriers, including the Douglas F3D Skynight and the McDonnell F2H-1 and -2 Banshees. In 1962 the Navy designated Moffett as the West Coast base for a new anti-submarine aircraft. For the next three decades, Lockheed P-3 Orions staged their Pacific patrols out of Moffett.

No matter which era of the base's history they lived through, alumni

Moffett Field Museum, Hangar One (by mail: P.O. Box 16), Moffett Field, CA 94035. Phone (415) 603-9827. Open Wed.-Sat., 10 a.m.-2 p.m.; 1st and 3rd Sundays, noon-2 p.m. Free admission; non-members must call before visiting.

NASA Ames Visitors Center, Moffett Field, CA 94035. Phone (415) 604-6274. Open Mon.-Fri., 8 a.m.-4:30 p.m. Free admission.

invariably find something in the museum that stirs memories. "This was their favorite base," explains museum director and founder Carol Henderson. "It was so unique in mission, size, and appearance." Because so many visitors have stories to tell about their time at Moffett, the staff members try to record what they can for the museum's oral history archive. One alumnus recalled the time a blimp crew on a routine flight spotted some young women in an orchard and dropped down to check them out. When the blimp got low enough, the women grabbed its landing lines and tethered it to a pear tree. Then a gust of wind blew through, and as the airship was buffeted, the tree was ripped from the ground. The embarrassed crew had to return to Moffett with a pear tree dangling from its blimp.

Henderson and Rose Lesslie are themselves Moffett alumni. Henderson and her husband, a Navy flight engineer,

transferred to the base in 1948. Lesslie worked as a blimp assembler and riveter at Moffett during World War II, and met her late husband there shortly before he shipped out for combat in the South Pacific. Today, Kermeth Lesslie's Marine uniform is exhibited at the museum.

Other artifacts on display include old newspapers, photographs, and scale models of aircraft that flew at Moffett. But what visitors will probably remember most vividly is the giant Hangar One, in which the museum is located. Built to house the *Macon*, Hangar One is 1,133 feet long and just under 200 feet high. San Francisco's 49ers use it for football practice when they can't train outside.

During the military base closings of the early 1990s, Moffett Field was earmarked to be shut down. Again, the area communities came together, this time arguing that the historic field should be transferred to the stewardship of NASA so it could be incorporated into the agency's nearby Ames Research Center. In 1992 that plan was approved.

The Ames center boasts its own museum, less than two miles from the one at Moffett Field. Though it can't compare in showmanship with the museums at the Kennedy and Johnson space centers, the Ames facility does include a moonrock, a Mercury space capsule, Al Worden's Apollo 15 spacesuit, a HiMAT remote-controlled aircraft, a U-2 spyplane, an F-104, and a one-third-scale space shuttle model. Visitors can also take a two-hour, two-mile walking tour of the center, which includes the world's largest wind tunnel, a centrifuge used for testing pilot reactions and equipment durability, and a fleet of 20 or so experimental and research aircraft, including Harrier vertical-takeoff-and-landing jets and Lockheed ER-2s, U-2 variants used for atmospheric studies.

Documenting 60 years of history with both traditional and uncommon artifacts, the two museums in the Moffett-Ames area will likely have something to interest almost every aerospace enthusiast.

—Tim Kincaid

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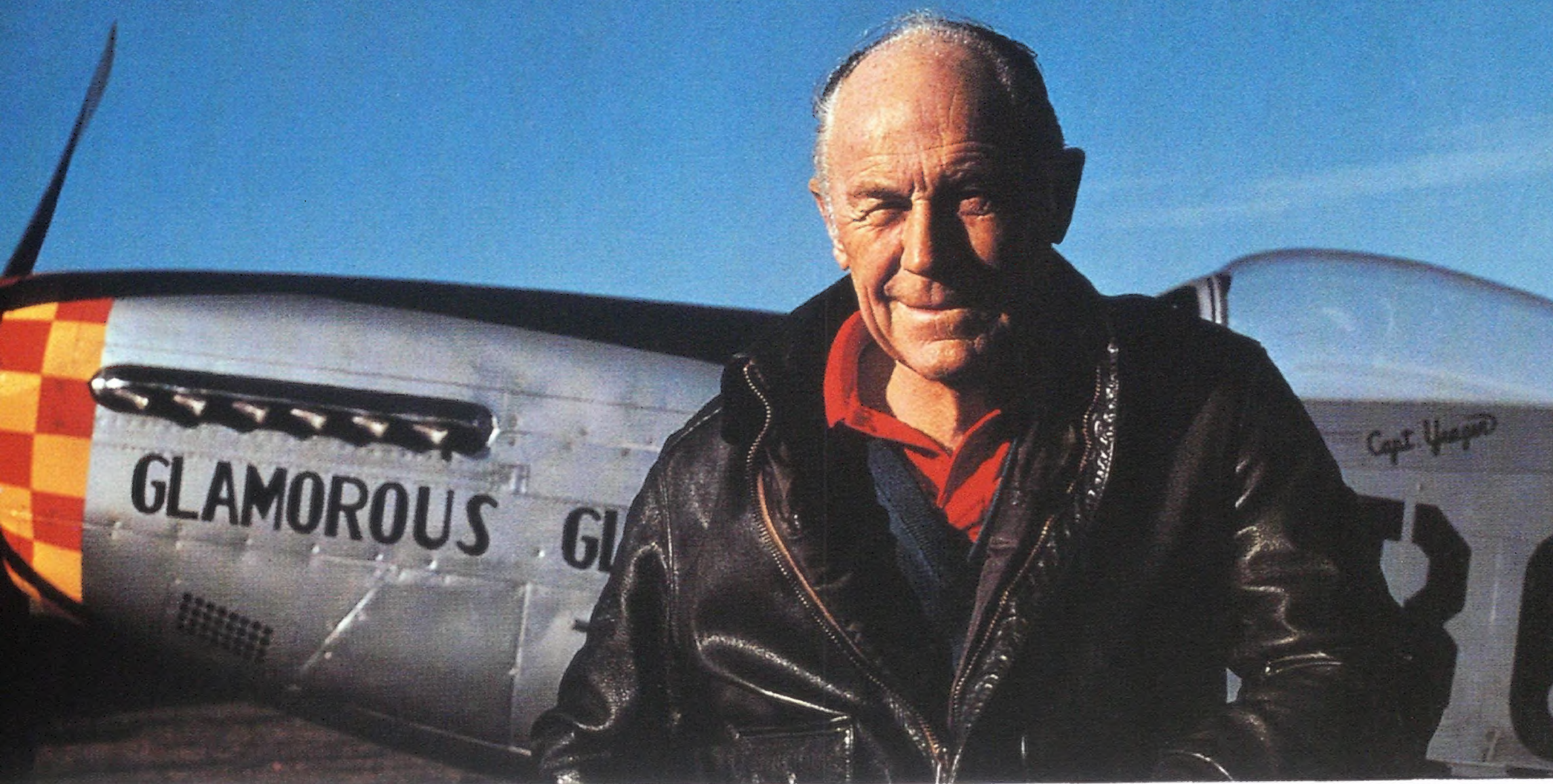
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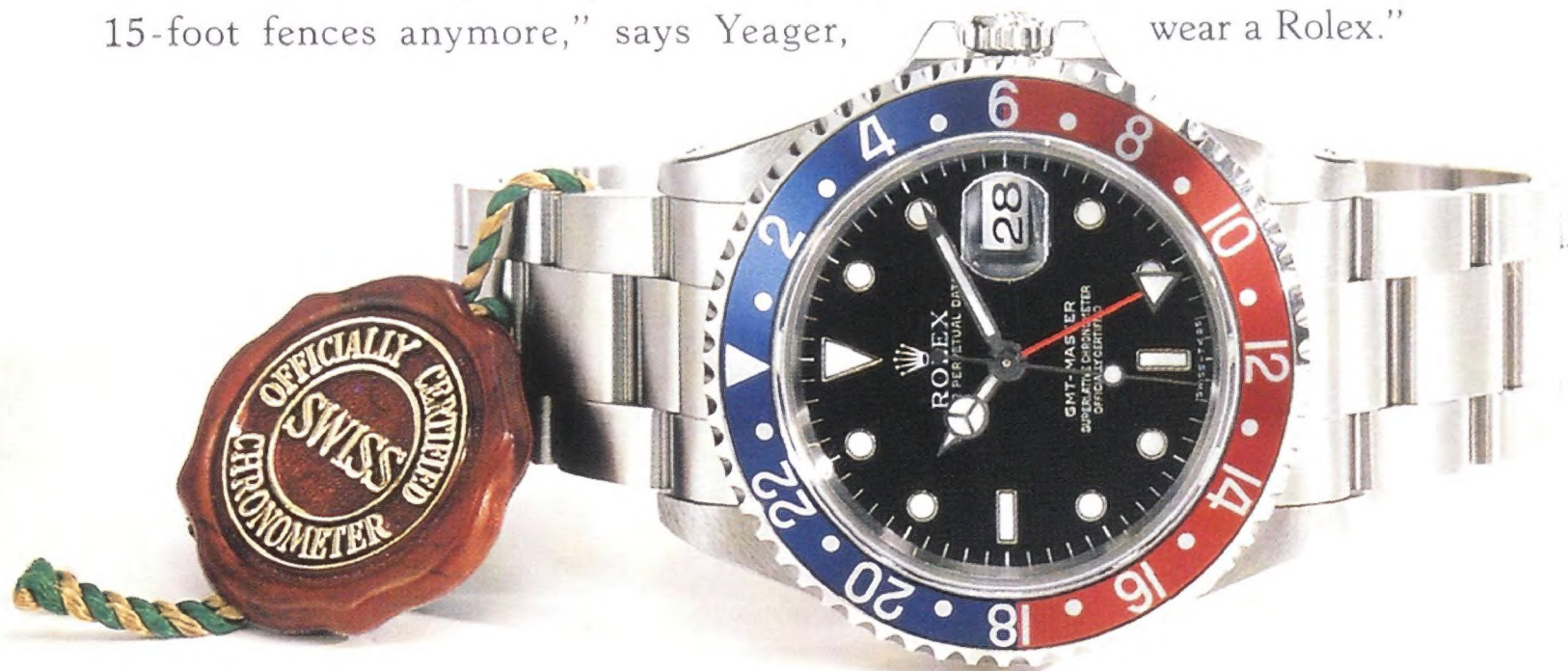
At 21, only three years after first boarding a plane, Chuck Yeager was leading a squadron of fighter pilots in World War II. And at the age of 24, he became the first person to fly faster than the speed of sound.


Yeager remains a man on the move. He’s an avid sportsman and a consulting test pilot who still loves to fly. “Maybe I don’t jump off 15-foot fences anymore,” says Yeager,

“but I can still pull 8 or 9 G’s in a high-performance aircraft.” And in all his exploits, Yeager depends on a rugged and reliable timepiece. “I wore a Rolex more than 40 years ago when I broke the sound barrier and I still do today,” says Yeager matter-of-factly.

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